MEMO

To: Michael Torres, United States Environmental Protection Agency – Region 6

From: Tom Biksey, EHS Support LLC

CC: Tommy Doran, Louisiana Department of Environmental Quality

Date: April 23, 2021

Re: SBA Shipyard Superfund Site - Fish Tissue Sampling Work Plan

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1 Introduction

On behalf of the SBA Shipyard PRP Group (SBA Group), EHS Support LLC (EHS Support) has prepared this *Fish Tissue Sampling Work Plan* (Work Plan) for the SBA Shipyard Superfund Site (Site) located in Jennings, Jefferson Davis Parish, Louisiana (**Figure 1**). This Work Plan was prepared in response to comments provided by the Louisiana Department of Environmental Quality (LDEQ), dated April 9, 2020, on the Baseline Human Health Risk Assessment (BHHRA) Work Plan (BHHRA Work Plan) and the BHHRA's updated Conceptual Exposure Model (CEM), dated October 23, 2019 (EHS Support, 2019b). The BHHRA is designed to support the Remedial Investigation/Feasibility Study (RI/FS) for the Site.

1.1 Investigation Background

The Site consists of 98 acres of land in a rural-industrial area and is comprised of two separately owned parcels (i.e., the northern and southern properties) (**Figure 1**). As part of the RI/FS Work Plan, Investigation Areas of Interest (IAIs) and Investigation Areas of Concern (IACs) were defined to direct Site investigation activities (**Figure 2**). The IAIs and IACs include:

- IAC-1 – Partially-Buried Barge
- IAC-2 – Boiler Barge and Aboveground Storage Tank (AST) Area (United States Environmental Protection Agency [USEPA] Source Area 2)
- IAC-3 – Barge Cleaning Surface Impoundments Area (USEPA Source Areas 3, 4, 5, 6, and 7)
- IAC-4 – Historical Waste Storage Area
- IAC-5 – Barge Cleaning Area Drainage Ditch
- IAC-6 – Barge Slip (USEPA Source Area 8)
- IAC-7 – Dry Dock (USEPA Source Area 9)
- IAI-1 – Southern Wetland Area
- IAI-2 – Additional Land Area on Southern Property, Land Area 1
- IAI-3 – Additional Land Area on Southern Property, Land Area 2
- IAI-4 – Additional Land Area on Southern Property, Land Area 3
- IAI-5 – Barge Maintenance Area on Northern Property

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- IAI-6 – Vessel Slip 1 on Northern Property
- IAI-7 – Vessel Slip 2 on Northern Property
- IAI-8 – Off-site Wetland Area

The RI/FS Work Plan (EHS Support, 2018) also identified the Mermentau River as an area of potential further evaluation given the Site's proximity to the river and the potential for historical releases from the Site to the river. As discussed in the RI/FS Work Plan, the RI/FS sampling program was designed using an iterative investigation approach that allowed for characterization of Site and background sediments and surface water during the initial phase of the remedial investigation (RI). These results were used to 1) inform decision-making related to potential sampling locations and analyses in the Mermentau River required to satisfy sediment and surface water-related RI objectives, and 2) address any sediment and surface water-related data gaps and key study questions (EHS Support, 2018). As concluded in the *Screening Level Ecological Risk Assessment* (SLERA; EHS Support, 2021a), the potential for adverse effects to ecological receptors from exposure to Site-related constituents in aquatic and wetland exposure areas with connectivity to the Mermentau River is considered to be negligible at sampling locations approaching the river, indicating that Site-related influences are confined to the Site and do not extend into the Mermentau River. Minimal risk to ecological receptors was identified in the following:

- Northern vessel slips (IAI-6 and IAI-7)
- Majority of the barge slip (IAC-6), particularly within the southeastern portion of the slip approaching the river
- Fan area outside of the dry dock (IAC-7)
- Southeastern segment of the drainage ditch (IAC-5)
- Majority of the southern wetland area (IAI-1), particularly approaching the river

Thus, no further assessment is recommended within these IACs/IAIs or the portions of these areas near the river (EHS Support, 2021a).

In addition to the conclusions presented in the SLERA (EHS Support, 2021a), the *Preliminary Site Characterization and Data Gap Assessment* (EHS Support, 2019a) did not identify concentrations of Site-related constituents in sediment warranting further evaluation in the Mermentau River due to human health concerns. Exceedances of direct contact human health screening criteria for volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and polychlorinated dibenzodioxins and dibenzofurans (dioxins/furans) were not identified in sediment collected from aquatic exposure areas with connectivity to the Mermentau River. Additionally, concentrations of polycyclic aromatic hydrocarbons (PAHs) in surface sediments from sample locations in aquatic exposure areas with connectivity to the Mermentau River attenuated longitudinally and did not exceed direct contact human health screening criteria at locations proximal to the river. To reduce uncertainty regarding the delineation of PAHs in sediment from the southern wetland area (IAI-1), particularly with respect to the Mermentau River, further sampling was conducted and demonstrated that PAHs are bound within IAI-1 (EHS Support, 2019b). With respect to metals, concentrations of metals in surface sediments exceeding direct contact human health screening criteria were generally consistent with background sediment concentrations and do not warrant further data collection in the Mermentau River. These results support the conclusion that Site-related influences are confined to the Site and do not extend into the Mermentau River.

Following submission of the RI/FS Work Plan (EHS Support, 2018), the off-site wetland area (IAI-8) also was identified as an IAI because of surface water drainage from the Northern Property to this wetland feature. Discharge from this wetland returns to the southern corner of the Northern Property via a ditch and crosses into the Southern Property where it eventually connects to IAC-5.

The updated CEM identified potentially complete exposure pathways for recreational fishermen to Site-related constituents via the consumption of fish and crawfish caught from selected Site features. The deeper, perennially inundated Site features that may provide potential habitat for fish include:

- IAC-6 – Barge Slip
- IAC-7 – Dry Dock
- IAI-6 and IAI-7 – Vessel Slips on Northern Property

Deeper waters, such as those Site features identified above, can limit crayfish abundance due to fish predation and reduced land-water interface habitat required for crayfish reproductive burrowing. The red swamp crayfish (*Procambarus clarkii*) and southern white river crayfish (*P. zonangulus*) thrive in wetland habitats that flood and dry seasonally, such as floodplain habitats of river systems, and are found in lesser abundance in perennially inundated, open water habitats. Red swamp and white river crayfishes are found in greatest abundance in shallow waters, ranging from 1.5 to 3.0 ft in depth. Ideal habitats include backwater, slow-moving, cypress-tupelo gum, hyacinth swamps, or natural bayous (Romaire, 2017).

The shallow, intermittently wetted Site features that may provide potential habitat for crawfish include:

- IAC-5 – Barge Cleaning Area Drainage Ditch
- IAI-1 – Southern Wetland Area
- IAI-8 – Off-site Wetland Area[1]

These Site features are representative of Site environmental conditions that may result in the bioaccumulation of Site-related constituents in fish and crawfish that may be caught and consumed by recreational fishermen.

The BHHRA Work Plan presented the technical approach to assess exposure of recreational fishermen to fish and crawfish caught and consumed from selected Site features. Exposure point concentrations (EPCs) of Site-related constituents in the edible tissue of fish and crawfish for the intake equations were proposed to be modeled using exposure assessment tools presented on the USEPA EXPOsure toolBOX ("EPA ExpoBox") website. Modeling of the exposure of Site-related constituents (e.g., bioaccumulation in fish and crawfish) was proposed to be based on the surface water and sediment concentrations of Site-related constituents in habitats representative of Site environmental conditions.

The LDEQ Risk Evaluation/Corrective Action Program (RECAP) perspective comment No. 5 requested the assessment of fish and crawfish bioaccumulation of Site-related constituents of potential concern (COPCs) by sampling fish and crawfish tissue to determine whether a fish consumption advisory is warranted (LDEQ, 2020). Specifically, the comment noted the following:

[1] Crawfish chimneys were observed in IAI-8 by field personnel during RI/FS sampling activities in June 2019.

> *The ingestion of fish from the Mermentau River has been identified as a current and future complete exposure pathway for the recreational fisherman. The only fish species of concern identified in the work plan is catfish, however, there are additional species of recreational concern in this area including striped, largemouth and smallmouth bass, sac-a-lait (crappie), and various sunfish species, freshwater drum, bowfin and gars [sic] species, as well as crustaceans such as crawfish. Also, since this river is tidally influenced, estuarine species must also be considered. It is recommended that consideration be given to the requirements provided in the document entitled Protocol for Issuing Public Health Advisories for Chemical Contaminants in Recreationally Caught Fish and Shellfish (Louisiana Department of Health; Louisiana Department of Environmental Quality; Louisiana Department of Wildlife and Fisheries, and Louisiana Department of Agriculture and Forestry). This document addresses data collection, health risk assumptions and calculations, when an advisory is warranted, and the requirements for an advisory to be rescinded. The fish data obtained from the investigation will be evaluated per this protocol by the Louisiana Department of Health to determine the need for a fish consumption advisory for the Mermentau River. If an advisory is necessary for the protection of human health for site-related COC, the requirements of this protocol will need to be met in order for the advisory to be lifted and, from an LDEQ perspective, for remediation to be adequate/complete. This protocol was included as to be considered (TBC) criteria to set remedial goals for fish tissue at another Superfund site in Louisiana for which a fish consumption advisory had been issued.*

During the initial teleconference to discuss the LDEQ comments on the BHHRA Work Plan and CEM on July 16, 2020, the recommendation to assess fish tissue data under the *Protocol for Issuing Public Health Advisories for Chemical Contaminants in Recreationally Caught Fish and Shellfish* (Protocol; LDHH et al., 2012) rather than bioaccumulation modeling was made by LDEQ. Subsequently, a proposed technical approach to address LDEQ's comment No. 5 was discussed during a conference call with the USEPA, LDEQ, and EHS Support on September 9, 2020. Specifically, the sampling of fish and crawfish species that reside in the Mermentau River was recommended for the exposure assessment of fish and crawfish consumption by the recreational fisherman. In addition, the Fish Consumption Advisory Committee was recommended for consultation pursuant to the preparation of this Work Plan.

The original RI/FS Work Plan (EHS Support, 2018) and BHHRA Work Plan (EHS Support, 2019b) did not include the assessment of organotins. However, the LDEQ requested the characterization of organotins in Site sediments in correspondence dated November 2, 2020, January 20, 2021, and March 17, 2021. Specifically, the request noted the following:

> *Antifouling paints historically included tributyltin and triphenyltin. These compounds are broken down in the environment into daughter compounds over time. For this reason, it is recommended that the following compounds be included as analytes: tributyltin, dibutyltin, monobutyltin, triphenyltin, diphenyltin, and monophenyltin.*

Therefore, this Work Plan includes organotins in the technical approach for the assessment of fish and crawfish tissue. The determination of whether or not organotins should be included as a Site-related constituent of potential concern (COPC) in the RI/FS will be based on the implementation of the *Organotins Sediment Sampling Work Plan* (EHS Support, 2021b). If selected as an RI/FS COPC, organotins will be included in the risk-based screening assessment for the fish advisory determination.

1.2 Investigation Objectives

The primary objective of this supplemental RI/FS investigation is to assess the potential for human exposure to Site-related constituents from the consumption of recreationally caught fish and crawfish. The fish and crawfish tissue sampling proposed within this Work Plan is intended to satisfy the following objectives:

- Address LDEQ's comment No. 5 on the BHHRA Work Plan and CEM.
- Address USEPA's and LDEQ's request for characterization of organotins, if warranted based on results of the Organotins Sediment Sampling Work Plan.
- Provide a robust data set to support determination of whether a fish consumption advisory may be warranted.

2 Technical Approach

This Work Plan was prepared in accordance with the Protocol (LDHH et al., 2012) and *Tissue Screening Level Guidelines for Issuance of Public Health Advisories for Selected Contaminants and Supporting Documentation* (TSL Guidelines; LDEQ et al., 2012). The proposed technical approach was also discussed with members (or designees) of the Fish Consumption Advisory Committee, including:

- Shannon Soileau - Louisiana Department of Health (LDHH)
- Al Hindrichs - LDEQ
- Sean Kinney[2] - Louisiana Department of Wildlife and Fisheries (LDFW)
- Harry Shexnayder - Louisiana Department of Agriculture and Forestry (LDAF)

The Fish Consumption Advisory Committee interviews and additional information referenced by the committee members were used to inform the proposed technical approach.

LDEQ comment No. 5 recommended an assessment of recreational fish species be considered pursuant to the requirements of the Protocol (LDHH et al., 2012) to determine if a fish consumption advisory is warranted. This recommendation is based on the identified potentially complete exposure pathway for recreational fishermen to Site-related COPCs. The Protocol (LDHH et al., 2012) notes that when a potential fish tissue exposure pathway may exist, a preliminary data collection is designed to screen targeted larger fish species that are commonly caught by the local population. This screening approach maximizes the detection of constituent concentrations in a single composite sample collected for each target species. If fish tissue constituent concentrations are detected that may be a human health concern, a comprehensive data collection may be conducted to provide a more robust data set to determine if a fish tissue consumption advisory is warranted.

The technical approach for this Work Plan is based on the preliminary screening guidelines provided in the Protocol (LDHH et al., 2012). The preliminary screening process recommends selecting targeted fish species for tissue analyses that represent bottom-feeding and pelagic predator species. The target analyte list for preliminary screening should include the bioaccumulative Site-related COPCs present in Site features to be assessed pursuant to the objectives of the fish consumption advisory.

[2] Designee.

2.1 Target Analytes

The Protocol (LDHH et al., 2012) identifies chemicals with a log octanol-water partition coefficient (K_{ow}) greater than or equal to 2.3 as the benchmark to identify bioaccumulative target analytes. In addition, the Protocol references the list of USEPA's commonly encountered bioaccumulative constituents from *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume I: Fish Sampling and Analysis* (USEPA, 2000) and includes the following general classes of bioaccumulative target analytes:

- Metals
- Organochlorine Pesticides
- Organophosphate Pesticides
- Chlorophenoxy Herbicides
- PAHs
- PCBs
- Dioxins/furans

Individual bioaccumulative target analytes for each class of constituents are presented in **Table 1**. This list was used as a conservative starting point to identify potential Site-related, bioaccumulative target analytes for this Work Plan.

The USEPA and LDEQ-approved RI/FS Work Plan (EHS Support, 2018) was developed based on key groups of constituents historically detected by USEPA at the Site and identified in the Administrative Settlement Agreement and Order on Consent (AOC) for RI/FS between USEPA – Region 6 and the SBA Group, dated October 25, 2017. Based on this review of historical operations and investigation data, the COPCs identified for the Site included:

- Metals
- PAHs
- Limited semi-volatile organic compounds (SVOCs) in waste samples
- VOCs
- PCBs
- Dioxins/furans

Metals, except for organotins, may be naturally occurring within the environment. Dioxins/furans are formed as a result of combustion processes such as commercial and municipal waste incineration or from burning fuels, such as wood, coal, and oil (USEPA, 2017). The remaining COPCs are believed to be attributed to product and residuals transported within barges and by-products of historical barge construction, maintenance, repair, and cleaning operations. Products typically held in the barges included diesel, coal tar, crude oil, gasoline, and asphalt. PAHs also may be partially attributable to other anthropogenic sources and natural diagenetic/biogenic processes as PAHs are ubiquitous in rivers and coastal environments in Louisiana (Iqbal et al., 2008).

There is no material evidence regarding the use, storage, or disposal of PCBs, pesticides, or herbicides during historical Site operations. In addition, PCBs were not detected in Site sediments collected as part of the RI/FS sampling program. Therefore, these constituents were not included as potential bioaccumulative, Site-related target analytes.

The conservative target analyte list was further refined, as presented in the following sections, to produce a list of Site-related, target analytes.

2.2 Selection of Bioaccumulative Site-Related Target Analytes

The purpose of this section is to select bioaccumulative, Site-related target analytes from the conservative target analyte list in order to focus the Work Plan on COPCs identified in the *Remedial Investigation, Preliminary Site Characterization and Data Gap Assessment* (EHS Support, 2019a). The Protocol (LDHH et al., 2012) recommends that all bioaccumulative chemicals known or suspected to be present in the waterbody should be included as target analytes in the assessment of a fish consumption advisory. As noted in LDEQ comment No. 5, a fish consumption advisory may be necessary for the protection of human health for "Site-related COCs."

The dataset used for refinement of the conservative target analyte list included surface water and sediment data (except for organotins and dioxins/furans) collected from Site features during the 2018 RI/FS sampling program. Organotins that were not originally identified as COPCs for the Site in the RI/FS Work Plan (EHS Support, 2018) will be evaluated as bioaccumulative, Site-related target analytes if warranted based on the results of the *Organotins Sediment Sampling Work Plan* (EHS Support, 2021b) as requested by LDEQ. Dioxins/furans were included in the RI/FS sampling program. However, data usability issues (e.g., blank contamination, qualification) warrant re-sampling of dioxins/furans in Site sediments at selected RI/FS locations in the barge slip (IAC-6) and drainage ditch (IAC-5). These locations will be sampled in 2021 in conjunction with sediment sampling for organotins. **Table 2** presents the bioaccumulative, Site-related target analytes selected from the project dataset that meet the classification of the conservative target analyte list for surface water or sediment.

The next selection steps include the comparison of Site-related target analytes to risk-based screening levels to determine which Site-related target analytes potentially may bioaccumulate in fish and crawfish tissue at concentrations that may adversely affect the health of recreational fishermen consuming these species. These steps focus the target analytes assessed in the Work Plan on the Site-related COPCs that have the potential to warrant a fish tissue consumption advisory. Although organotins are included in the technical approach; the comparison of the risk-based screening levels to Site-related organotin concentrations will be based on the COPC determination from the implementation of the *Organotins Sediment Sampling Work Plan* (EHS Support, 2021b).

2.2.1 Surface Water Screening

The identification of bioaccumulative, Site-related target analytes in surface water for the fish and crawfish consumption pathway was based on a comparison of maximum detected concentrations (MDCs) with toxicity-based screening concentrations protective of the fish consumption exposure pathway. The frequency of detection and representative regional background concentrations were used to refine the list of bioaccumulative, Site-related target analytes. Constituents with a frequency of detection of less than 5 percent were eliminated from further consideration in the screening process as constituents that are detected very infrequently are not likely to contribute significantly to overall risk (USEPA, 1989). Constituents with MDCs below their corresponding background threshold values (BTVs) were also eliminated from further consideration in the screening process as these conditions are representative of regional background conditions which would occur in the absence of the Site.

To select bioaccumulative, Site-related target analytes for surface water, surface water data collected from the Site features identified in **Section 1.1** were screened using the following screening criteria from the approved RI/FS Work Plan (EHS Support, 2018):

- LDEQ – Human Health Protection Drinking Water Supply (Louisiana Administrative Code [LAC] Title 33 Part IX. Subpart 1; February 2019)
- USEPA National Recommended Water Quality Criteria (NRWQC) – Human Health for the Consumption of Water and Organisms

If a Site-related COPC did not have an applicable human health screening criterion, a screening criterion for a surrogate constituent was used, where available and applicable. Surrogates were selected based on structural similarity and molecular weight, as well as toxicologically similar effects.

Table 3 presents the selection of bioaccumulative, Site-related target analytes for surface water. In addition to the screening levels, minimum and maximum detections, detection frequency, and range of detection limits are also included in this table.

Detected chemicals without screening levels included the PAHs acenaphthylene, benzo[g,h,i]perylene, and phenanthrene. An established toxicological surrogate for these PAHs without screening levels is pyrene (Copeland and Fehling, 2006). Maximum detected concentrations of acenaphthylene (0.07 micrograms per liter [µg/L]), benzo(g,h,i)perylene (0.1 µg/L), and phenanthrene (0.3 µg/L) did not exceed the risk-based screening level for pyrene (20 µg/L). Therefore, these constituents were not retained as COPCs for surface water.

Detected chemicals exceeding the human health screening levels for fish consumption include the following PAHs:

- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Indeno(1,2,3-c,d)pyrene

These PAHs will be included as bioaccumulative, Site-related target analytes.

2.2.2 Sediment Screening

Similar to the surface water screening approach, surficial sediment data (0.0 to 0.5 foot depth interval) from the Site features identified in **Section 1.1** were used to identify bioaccumulative, Site-related target analytes for the fish and crawfish consumption pathway (**Table 4** and **Table 5**). Dioxins/furans, metals, and PAHs were detected in sediments from Site features. As discussed in **Section 2.1**, PCBs were not detected in sediments collected as part of the RI/FS sampling program and there is no material evidence regarding the use, storage, or disposal of PCBs during historical Site operations. Therefore, PCBs were not included as bioaccumulative, Site-related target analytes. The surficial sediment dataset was grouped based on applicable receptor habitats, including data for Site features that may provide fish habitat (i.e., IAC-6 – Barge Slip, IAC-7 – Dry Dock, and IAI-6 and IAI-7 – Vessel Slips 1 and 2 on Northern Property) and Site features that may provide crawfish habitat (i.e., IAC-5 – Barge Cleaning Area Drainage Ditch, IAI-1 – Southern Wetland Area, and IAI-8 – Off-site Wetland Area). Additionally, at the request of

LDEQ, sediment data for several additional Site features (i.e., IAC-6, IAC-7, IAI-6, and IAI-7) were included as potential crawfish habitat.[3] **Table 4** presents the minimum and maximum detections, detection frequency, and range of detection limits for constituents in surface sediments from Site features that may provide potential fish habitat. **Table 5** presents minimum and maximum detections, detection frequency, and range of detection limits for constituents in surface sediments from Site features that may provide potential crawfish habitat.

BTVs developed in the SLERA (EHS Support, 2021a), are presented in **Table 4** and **Table 5**. As discussed in **Section 1.1**, concentrations of metals in surface sediments were generally consistent with background sediment concentrations. Maximum concentrations of arsenic, cadmium, and selenium in surface sediments did not exceed BTVs for either the fish or crawfish habitat datasets. Therefore, these metals were not included as Site-related target analytes.

Human health screening levels protective of the fish ingestion pathway were not available for sediment; however, fish tissue screening levels (TSLs) were available or, where not available, were calculated based on equations and exposure assumptions in the TSL Guidelines (LDHH et al., 2012). **Table 6** presents the available LDEQ TSLs, toxicity values, and exposure assumptions for calculations where an established LDEQ TSL is not available. Also included in this table are the equations used to calculate each TSL.

To account for potential additive health effects, the target individual hazard quotient was adjusted based on the number of noncarcinogens that affect the same target organ endpoint or have the same critical effect. Similarly, for carcinogenic COPCs, the target individual chemical risk was apportioned based on the number of carcinogens.

If a Site-related COPC did not have an applicable human health screening criterion, a screening criterion for a surrogate constituent was used, where available and applicable. Surrogates were selected based on structural similarity and molecular weight, as well as toxicologically similar effects.

To compare sediment concentrations to the TSLs, a biota-sediment accumulation factor (BSAF) was applied to each COPC to estimate fish (**Table 7**) and benthic invertebrate tissue concentrations (**Table 8**) for bioaccumulative, Site-related COPCs in sediments. Sources of the literature-based BSAFs are provided in **Table 7** and **Table 8**, and references are included in **Section 8**. The BSAFs were included in **Table 7** and **Table 8** for organotins and dioxins/furans for future evaluation of sediment data, if warranted based on results of the *Organotin Sediment Sampling Work Plan* (EHS Support, 2021b) and re-sampling for dioxins/furans.

The use of BSAFs to predict biota exposure from sediment-associated COPCs relies on several key assumptions including that the assessed sediments are in steady state with the biota and the sediments are the primary source of COPC exposure to the biota being modeled (Melwani et al., 2009). Because the relative potential fish and crawfish habitat within the Site features is considerably less than the potential fish and crawfish habitat in the Mermentau River, the expected duration of Site-related

[3] Teleconference between SBA Group, EHS Support, USEPA, and LDEQ on February 24, 2021 where crawfish sampling in Site features IAC-7, IAC-6, IAI-6, and IAI-7 was requested by LDEQ.

exposure is expected to be less than continuous. In addition, the highly modified habitat conditions of the Site features are likely to further limit potential exposure in favor of more natural habitats in the Mermentau River. As a conservative measure, the BSAF model assumes that fish and crawfish are continuously exposed to the COPCs in the sediments associated with the Site features.

Both inorganic mercury and methylmercury have been included as target analytes as a conservative measure based on regional background conditions including the existing fish consumption advisories for mercury in the three main tributaries forming the Mermentau River that converge upstream from the Site, including Bayou Nezpique, Bayou des Cannes, and Bayou Plaquemine Brule.[4] Mercury was not included in the BSAF modeling. The RI/FS sampling program included the evaluation of inorganic mercury in sediments. Microbially mediated conversion of inorganic mercury to organic methylmercury in sediments and bioaccumulation in biota is the main exposure pathway for mercury in aquatic ecosystems with the total mercury detected in fish tissue being predominantly methylmercury (Scudder et al., 2009). Environmental factors may affect inorganic mercury methylation including loss-on-ignition (LOI, a measure of organic matter content), acid-volatile sulfide in bed sediment, pH, dissolved organic carbon (DOC), and dissolved sulfate in water.

The potential additive exposure to dioxins/furans will be evaluated using the toxicity equivalence approach consistent with LDEQ (2013) and USEPA (2008). The maximum concentration for the 17 individual dioxin and furan compounds was multiplied by the compound-specific toxicity equivalence factor (TEF) relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) to estimate the toxicity equivalence concentration (TEQ) for each compound (Van den Berg et al., 1998; Van den Berg et al., 2006; USEPA, 2008). Next, the individual congener BSAF was applied to the sediment concentration. To calculate an overall TEQ for dioxins/furans, individual TECs of the 17 dioxin and furan compounds were summed using the following equation:

$$TEQ = \sum_{n=1}^{k} Csed_n \times TEF_n$$

where:

- TEQ = Toxicity equivalence concentration
- $Csed_n$ = Concentration in sediment of dioxin-like chemical *n*
- TEF_n = Toxicity equivalence factor for dioxin-like chemical *n*
- k = Number of toxic dioxin-like chemicals in the mixture

The calculated TEQ was compared to the LDEQ TSL for Total TEQ.

Similar to surface water, detected chemicals without screening levels included the PAHs acenaphthylene, benzo[g,h,i]perylene, and phenanthrene. An established toxicological surrogate for PAHs without screening levels is pyrene (Copeland and Fehling, 2006). The TSL calculated for pyrene was used as a surrogate for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene. The predicted fish

[4] https://deq.louisiana.gov/assets/docs/Water/Fish_Swim_Advisories/Fish_Consumption_Advisory_Table-01-02-19_with_subsegments.pdf

(**Table 7**) and benthic invertebrate (**Table 8**) tissue concentrations for these PAHs exceeded the calculated TSLs for pyrene. Therefore, these PAHs were retained as target analytes for sediment.

The bioaccumulative, Site-related target analytes include metals and PAHs are presented in **Table 9**. Predicted fish tissue concentrations exceeded the applicable TSL for multiple PAHs (acenaphthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, dibenzo[a,h]anthracene, fluoranthene, indeno[1,2,3-c,d]pyrene, naphthalene, phenanthrene, and pyrene). For benthic invertebrates, mercury and PAHs had predicted concentrations that exceeded calculated TSLs. Therefore, mercury and PAHs were retained as target analytes for sediments for the potential ingestion of fish and crawfish exposure pathway.

2.3 Fish and Crawfish Tissue Sampling Methodology

The CEM identified a potentially complete exposure pathway for recreational fishermen to Site-related COPCs in fish and crawfish tissue via the consumption of these species from Site features. Recreational fishermen have the potential for exposure to Site-related COPCs through the direct ingestion of fish and crawfish tissue which may bioconcentrate and bioaccumulate Site-related COPCs from surface water and sediment. Therefore, the bioaccumulation exposure pathway will be evaluated through the assessment of Site-related COPCs in fish and crawfish tissue. The sampling and analysis plan for fish and crawfish tissue is presented in the following sections.

2.3.1 Sampling Design

This fish and crawfish tissue sampling plan is designed to evaluate concentrations of Site-related COPCs in the tissue of representative fish and crawfish species from relevant Site features. The target species identified for assessment are considered common, year-round residents within Louisiana and the Mermentau River, and are recreational fish and crawfish species that may be caught for potential human consumption. The target species selected for sampling include:

- **Bottom-Feeder**: Channel Catfish (*Ictalurus punctatus*) will be the target bottom-feeding fish species. Blue Catfish (*I. furcatus*) will serve as a potential surrogate species if Channel Catfish abundance is low.
- **Predator**: Largemouth Bass (*Micropterus salmoides*) will be the target pelagic predator fish species. Spotted Bass (*M. punctulatus*) will serve as a potential surrogate species if Largemouth Bass abundance is low.
- **Crawfish**: Red swamp (*Procambarus clarkii*) and southern white river (*P. zonangulus*) crawfish will be the target crawfish species.

The small size (e.g., IAI-6 and IAI-7) and physically degraded habitats of the heavily modified, man-made Site features (e.g., IAC-7) may not support large populations of fish or crayfish for sampling. Therefore, other surrogate fish species may need to be considered for tissue analysis depending on the abundance and catch rates of the target species listed above. If suitable numbers and sizes of appropriate surrogate species are not captured, the number of proposed tissue samples may be reduced accordingly.

2.3.2 Sample Locations

The Site features that provide potential habitat for fish include:

- IAC-6 – Barge Slip
- IAC-7 – Dry Dock
- IAI-6 and IAI-7 – Vessel Slips 1 and 2 on Northern Property

The Site features that provide potential habitat for crawfish include:

- IAC-5 – Barge Cleaning Area Drainage Ditch
- IAI-1 – Southern Wetland Area
- IAI-8 – Off-site Wetland Area

Other Site features that will be sampled for crawfish based on comments received from LDEQ during the February 24, 2021 teleconference include[5]:

- IAC-6 – Barge Slip
- IAC-7 – Dry Dock
- IAI-6 and IAI-7 – Vessel Slips 1 and 2 on Northern Property

As discussed in the introduction, these features are representative of Site environmental conditions that may result in bioaccumulation of Site-related COPCs (i.e., target analytes) in fish and crawfish tissue that may be consumed by recreational fishermen. These Site features will be sampled for the target fish and crawfish species. In addition, upstream and downstream background locations will be sampled on the Mermentau River to characterize representative regional conditions.

2.3.3 Collection Methods

Fish and crawfish tissue samples will be collected in accordance with the conditions stated in the LDWF scientific collection permit and Standard Operating Procedures (SOPs) provided in **Attachment A**. A scientific collection permit will be obtained from the LDWF before commencement of sampling. Fish and crawfish will be collected using a combination of passive and active gear types in accordance with the conditions stated in the scientific collection permit. Collections may include the use of crawfish traps, hoop nets, trot lines, gill nets, hook and line, electrofishing, and other common gear types, as necessary, based on Site-specific conditions. All non-target fish species captured will be released as quickly as possible to minimize handling stress.

The target fish and crawfish species will be processed as follows:

- Examine and record any gross physical anomalies.
- Measure fish total length and crawfish carapace length to the nearest millimeter (mm), and weigh to the nearest gram (g).

[5] Although these man-made slip and dry dock features are not anticipated to support populations of crawfish capable of supporting recreational fisheries due to the physically degraded habitat conditions and permanently inundated nature of these Site features (i.e., lack of habitats subject to seasonal wetting and drying which are critical for crawfish reproduction), they are being included here based on comments received from LDEQ during the February 24, 2021 teleconference between the SBA Group, EHS Support, USEPA, and LDEQ. As with all biological sampling programs, catch rates cannot be predetermined and final sample counts will be dependent on organism presence and abundance.

- Rinse with deionized water to remove any residual sediment.
- Place into laboratory-supplied sample containers, temporarily hold in cooler on wet ice, and freeze as soon as logistically possible.

Note:
Tissue processing, including fish filleting and crawfish picking, will be conducted by the contracted analytical laboratory to provide more controlled conditions and minimize potential for cross contamination.

Fish tissue samples will be comprised of composite samples of skin-off fillets from multiple fish (minimum of three) of a similar size (i.e., smallest fish will be greater than 85 percent of the length of the largest fish). Surrogate fish species may be sampled where target fish species abundance is low. Crawfish tissue samples will be comprised of composite samples of abdominal muscle tissue from multiple individuals (minimum of five) to meet the mass required for analytical analyses.[6]

The number of composite samples to be collected by location and target species is presented in **Table 10**. For bottom-feeders (i.e., catfish) and predatory fishes (i.e., bass), one composite sample of skin-off fillets will be collected from each of the following areas:

- IAC-6 – Barge Slip
- IAC-7 – Dry Dock
- IAI-6 and IAI-7 – Vessel Slips 1 and 2 on Northern Property
- Background – Upstream and downstream locations on Mermentau River

For crawfish, one composite sample of abdominal muscle tissue will be collected from each of the following areas:

- IAC-6 – Barge Slip
- IAC-7 – Dry Dock
- IAI-6 and IAI-7 – Vessel Slips 1 and 2 on Northern Property
- IAC-5 – Barge Cleaning Area Drainage Ditch
- IAI-1 – Southern Wetland Area
- IAI-8 – Off-site Wetland Area
- Background – Upstream and downstream locations on Mermentau River

Although, the man-made slip and dry dock features (i.e., IAC-6, IAC-7, IAI-6, and IAI-7) are not anticipated to support populations of crawfish capable of supporting a recreational fishery due to the small size (e.g., IAI-6 and IAI-7), heavily modified condition (e.g., IAC-7), and/or physically degraded habitat conditions, they are included here at the request of LDEQ. As with all proposed fish and crawfish samples, final sample counts will be dependent on organism presence and abundance.

Fish and crawfish samples will be placed in laboratory-supplied sample containers, frozen, and shipped on dry ice under proper chain-of-custody (C-O-C) via overnight courier to a certified analytical laboratory for analysis.

[6] The numbers of individual fish and crawfish per composite sample may vary depending on organism abundance. If minimum composite sizes are not attainable, but tissue mass is sufficient for laboratory analytical analysis, fewer individuals per composite may be submitted.

2.3.4 Laboratory Analytical Scope

Fish and crawfish tissue samples will be submitted to a certified analytical laboratory for the following analyses:

- PAHs by USEPA Method 8270D LL
- Total mercury (THg) analyzed by USEPA Method 1631
- Methylmercury (MeHg) analyzed by USEPA Method 1630
- Dioxins/furans analyzed by USEPA Method 8290A[7] – Analysis is contingent upon results of on-site re-sampling of surficial sediment in IAC-6 and IAC-5 (to minimize uncertainty regarding laboratory blank contamination associated with 2018 RI/FS analytical results) and comparison to representative regional background conditions. If results for re-sampled sediment are less than the range of background concentrations, no further assessment will be recommended as on-site conditions are reflective of regional background conditions. If concentrations of dioxins/furans in re-sampled sediments are greater than the range of background concentrations and exceed the TSL, analysis in fish and crawfish tissue will be performed.
- Organotins, including tributyltin (TBT) and degradation products dibutyltin and monobutyltin by laboratory specific method CASW SOC-BUTYL Rev. 8, GC-FPD [8] – Analysis is contingent upon results of the sediment sampling in IAC-7 and comparison to representative regional background conditions. If results for on-site sediment are less than the range of background concentrations, no further assessment will be recommended as on-site conditions are reflective of regional background conditions. If concentrations of TBT in on-site sediments are greater than background and exceed the TSL, analysis in fish and crawfish tissue will be performed.
- Percent lipids
- Percent moisture

The analytical methods and sample handling requirements for the analysis of fish and crawfish tissue samples are summarized in the QAPP.

2.3.5 Analytical Data Quality Objectives

The QAPP provided to USEPA and LDEQ as Appendix K of the RI/FS Work Plan (EHS Support, 2018) has been updated to include the necessary QA/QC procedures and protocols. Fish tissue samples will be frozen shortly after field collection, shipped on dry ice, and submitted to a certified analytical laboratory under proper C-O-C in accordance with the SOPs provided in the RI/FS Work Plan (EHS Support, 2018). Tissue analyses will be performed following USEPA-approved methods. Reporting limits and method detection limits for fish tissue are presented in the QAPP.

In addition to field samples, QA/QC samples will be analyzed by the laboratory. QA/QC samples will include duplicate analyses of submitted sample volumes and MS/MSD analyses. Duplicate samples and

[7] Dioxins/furans will be included on the C-O-C and placed on "hold for analysis" by the laboratory pending analytical results for sediment as outlined above.

[8] Organotins will be included on the C-O-C and placed on "hold for analysis" by the laboratory pending analytical results for sediment as outlined above.

MS/MSD samples will be collected at a rate of 5 percent of the total samples collected for the study in accordance with the SOPs provided in **Attachment A**.

Samples will be clearly labeled and handled according to the C-O-C procedures outlined in SOPs provided in the RI/FS Work Plan (EHS Support, 2018). Each sample will be labeled using waterproof ink with the station location, date, and time of collection; initials of sampling personnel; requested analyses; and method of preservation. A C-O-C form will be prepared to document the possession of the samples from collection through transport/shipping, storage, and analysis to data reporting and disposal. The times of sample collections and relevant observations will be recorded in the field log.

3 Fish Advisory Determination

A fish advisory determination will be conducted using the fish and crawfish tissue data that are usable for risk-based decision-making. The concentrations of target analytes detected in fish and crawfish tissue will be compared to the risk-based screening levels developed in the target analyte selection process. The results of this comparison, along with a comparison to regional background concentrations of target analytes in fish and crawfish tissue, will be used to inform the need for a fish advisory.

3.1 Data Validation and Usability

Data verification and validation will be performed to confirm that laboratory analytical data meet the data quality objectives (DQOs) outlined in the RI/FS Work Plan (EHS Support, 2018) and QAPP. Laboratory analytical results will undergo data usability assessment to establish whether the reported analytical results are of acceptable quality for use in the fish advisory determination and to identify any reported results that are invalid. Following the data usability assessment, 10 percent of laboratory sample delivery group (SDG) reports will go through a Tier II data validation review. Data validation will be performed to determine whether the laboratory was operating within applicable limits and which, if any, sample results were related to QC results that were outside control limits. If any data are rejected as a result of data validation, the data will not be included in the dataset for the fish advisory determination.

3.2 Risk-Based Screening Assessment

The fish and crawfish tissue data will be managed electronically and compiled by target analyte, fish or crawfish species, and sample location. All descriptive and statistical analyses of the data will be performed using ProUCL Version 5.1 software that was developed for USEPA (USEPA, 2016).

An arithmetic mean of target analyte concentration in wet weight will be calculated for each fish or crawfish species for the EPC of the edible fish and crawfish tissue. The arithmetic mean is the most representative of current exposure conditions (LDHH et al., 2012). The EPC will be compared to the tissue screening levels developed in **Section 2.2**. In addition, the EPCs for target analyte concentrations in fish and crawfish tissue from Site features will be compared to fish and crawfish tissue collected from upriver and downriver background locations in the Mermentau River to assess the potential contribution of regional environmental conditions on the concentrations of bioaccumulative, Site-related target analytes identified in tissue from Site features.

The results of the fish advisory determination will be presented in a *Fish Tissue Sampling Report* at the conclusion of the assessment.

4 Health and Safety Plan

Field activities will be conducted in accordance with the Health and Safety Plan (HASP) for the Site and any applicable federal, state, and/or local guidance regarding COVID-19 precautions in place at the time of sampling. The HASP outlines procedures that will allow personnel to work safely and respond quickly and appropriately to Site emergencies. Site work will be conducted in accordance with Occupational Safety and Health Administration regulations in the Code of Federal Regulations, Title 29 Parts 1904, 1910, and 1926. A copy of the HASP will be available at all times during sampling for reference.

Prior to mobilization into the field, a project safety analysis (PSA) will be conducted with the sampling team, subcontractor, and health and safety personnel to identify hazards, discuss hazard communication, and identify roles and responsibilities. In addition, daily safety tailgate meetings will be conducted with the sampling team to review health and safety topics, share health and safety information, and communicate potential hazards.

5 List of Tables

6 List of Figures

7 Attachments

8 References

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Tables

Table 1
Bioaccumulative Target Analytes
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

General Class	Target Analyte
Metals	Arsenic (inorganic)
	Cadmium
	Mercury (methylmercury)
	Selenium
	Tributyltin
Organochlorine Pesticides	Chlordane, total (cis- and trans-chlordane, cis- and trans-nonachlor, oxychlordane)
	DDT, total (2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, 4,4'-DDT)
	Dicofol
	Dieldrin
	Endosulfan (I and II)
	Endrin
	Heptachlor epoxide (metabolite of heptachlor and chlordane)
	Hexachlorobenzene
	Lindane (y-hexachlorocyclohexane; y-HCH or -benzene hexachloride (-BHC))
	Mirex
	Toxaphene
Organophosphate Pesticides	Chlorpyrifos
	Diazinon
	Disulfoton
	Ethion
	Terbufos
Chlorophenoxy Herbicides	Oxyfluorfen
Polycyclic aromatic hydrocarbons (PAHs)	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo[a]anthracene
	Benzo[a]pyrene
	Benzo[b]fluoranthene
	Benzo[g,h,i]perylene
	Benzo[k]fluoranthene
	Chrysene
	Dibenz(A,H)Anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-C,D)Pyrene
	Phenanthrene
	Pyrene
Polychlorinated biphenyls (PCBs)	PCB-1016 (Aroclor 1016)
	PCB-1221 (Aroclor 1221)
	PCB-1232 (Aroclor 1232)
	PCB-1242 (Aroclor 1242)
	PCB-1248 (Aroclor 1248)
	PCB-1254 (Aroclor 1254)
	PCB-1260 (Aroclor 1260)
Polychlorinated dibenzodioxins and dibenzofurans	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
	1,2,3,4,6,7,8-Heptachlorodibenzofuran
	1,2,3,4,7,8,9-Heptachlorodibenzofuran
	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
	1,2,3,4,7,8-Hexachlorodibenzofuran
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
	1,2,3,6,7,8-Hexachlorodibenzofuran
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin
	1,2,3,7,8,9-Hexachlorodibenzofuran
	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
	1,2,3,7,8-Pentachlorodibenzofuran
	2,3,4,6,7,8-Hexachlorodibenzofuran
	2,3,4,7,8-Pentachlorodibenzofuran
	2,3,7,8-Tetrachlorodibenzo-p-dioxin
	2,3,7,8-Tetrachlorodibenzofuran
	Octachlorodibenzo-p-dioxin
	Octachlorodibenzofuran

DDT = Dichlorodiphenyltrichloroethane

Table 2
Bioaccumulative Site-Related Target Analytes
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

Target Analyte Class	CAS Number	Target Analyte Name	log Kow	log Kow >=2.3?
Dioxin/Furan	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	NA	NA
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA	NA
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA	NA
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	NA	NA
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	NA	NA
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	NA	NA
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	NA	NA
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	NA	NA
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	NA	NA
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	NA	NA
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	NA	NA
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	NA	NA
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	NA	NA
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	6.8	YES
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	NA	NA
	3268-87-9	Octachlorodibenzo-p-dioxin	NA	NA
	39001-02-0	Octachlorodibenzofuran	NA	NA
	TEQWHO05-0.0	Dioxin Toxic Equivalency (WHO 2005)	6.8	YES
Metals[2]	7440-38-2	Arsenic	NA	NA
	7440-43-9	Cadmium	NA	NA
	7439-97-6	Mercury[1]	0.62	NO
	7782-49-2	Selenium	NA	NA
PAHs	83-32-9	Acenaphthene	3.92	YES
	208-96-8	Acenaphthylene	3.93	YES
	120-12-7	Anthracene	4.45	YES
	56-55-3	Benzo[a]anthracene	5.76	YES
	50-32-8	Benzo[a]pyrene	6.13	YES
	205-99-2	Benzo[b]fluoranthene	5.78	YES
	191-24-2	Benzo[g,h,i]perylene	6.63	YES
	207-08-9	Benzo[k]fluoranthene	6.11	YES
	218-01-9	Chrysene	5.81	YES
	53-70-3	Dibenz(A,H)Anthracene	6.75	YES
	206-44-0	Fluoranthene	5.16	YES
	86-73-7	Fluorene	4.18	YES
	193-39-5	Indeno(1,2,3-C,D)Pyrene	6.7	YES
	85-01-8	Phenanthrene	4.46	YES
	129-00-0	Pyrene	4.88	YES

Notes:
Kow = octanol-water coefficient
NA = not available
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyl
WHO = World Health Organization
1/ Mecury retained because of potential transformation to methylmercury which is bioaccumulative.
2/ Organotin requested by USEPA and LDEQ; tributyltin used for representative surrogate for Kow.

Table 3
Summary of Surface Water Data and Screening
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

CAS Numbers	Analyte Name		Minimum Detection	Maximum Detection	Units	Location of Maximum	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	Risk-Based Screening Level
7440-38-2	Arsenic	T	ND	ND	ND	ND	0 / 27	16 - 50	ND	10 LDEQ - Water Quality Criteria - HH Drinking Water Feb 2019
7440-43-9	Cadmium	T	ND	ND	ND	ND	0 / 27	1 - 5	ND	10 LDEQ - Water Quality Criteria - HH Drinking Water Feb 2019
7439-97-6	Mercury	T	0.052 (J)	0.052 (J)	µg/L	SW-0035	1 / 27	0.05 - 0.2	0.052	2 LDEQ - Water Quality Criteria - HH Drinking Water Feb 2019
7782-49-2	Selenium	T	ND	ND	ND	ND	0 / 27	21 - 50	ND	170 USEPA NRWC HH Water + Org
83-32-9	Acenaphthene	NA	0.01 (J)	0.1	µg/L	SW-0035	9 / 27	0.01 - 0.05	0.1	70 USEPA NRWC HH Water + Org
208-96-8	Acenaphthylene	NA	0.01 (J)	0.07	µg/L	SW-0021	9 / 27	0.01 - 0.05	0.07	No Screening Level
120-12-7	Anthracene	NA	0.03 (J)	0.4	µg/L	SW-0017	11 / 27	0.01 - 0.05	0.4	300 USEPA NRWC HH Water + Org
56-55-3	**Benzo[a]anthracene**	NA	**0.01 (J)**	**0.04 (J)**	**µg/L**	**SW-0021**	**9 / 27**	**0.01 - 0.05**	**0.04**	**0.0012 USEPA NRWC HH Water + Org**
50-32-8	**Benzo[a]pyrene**	NA	**0.01 (J)**	**0.07**	**µg/L**	**SW-0021**	**7 / 27**	**0.01 - 0.05**	**0.07**	**0.0001 USEPA NRWC HH Water + Org**
205-99-2	**Benzo[b]fluoranthene**	NA	**0.01 (J)**	**0.09**	**µg/L**	**SW-0021**	**12 / 27**	**0.05 - 0.05**	**0.09**	**0.0012 USEPA NRWC HH Water + Org**
191-24-2	Benzo[g,h,i]perylene	NA	0.01 (J)	0.1	µg/L	SW-0017	11 / 27	0.01 - 0.05	0.1	No Screening Level
207-08-9	**Benzo[k]fluoranthene**	NA	**0.01 (J)**	**0.03 (J)**	**µg/L**	**SW-0021**	**5 / 27**	**0.01 - 0.05**	**0.03**	**0.012 USEPA NRWC HH Water + Org**
218-01-9	Chrysene	NA	0.01 (J)	0.05 (J)	µg/L	SW-0021	10 / 27	0.01 - 0.05	0.05	0.12 USEPA NRWC HH Water + Org
53-70-3	Dibenz(A,H)Anthracene	NA	ND	ND	ND	ND	0 / 27	0.02 - 0.08	ND	0.0001 USEPA NRWC HH Water + Org
206-44-0	Fluoranthene	NA	0.01 (J)	0.1	µg/L	SW-0013	13 / 27	0.05 - 0.05	0.1	20 USEPA NRWC HH Water + Org
86-73-7	Fluorene	NA	0.01 (J)	0.3	µg/L	SW-0035	11 / 27	0.01 - 0.05	0.3	50 USEPA NRWC HH Water + Org
193-39-5	**Indeno(1,2,3-C,D)Pyrene**	NA	**0.01 (J)**	**0.1**	**µg/L**	**SW-0021**	**10 / 27**	**0.01 - 0.05**	**0.1**	**0.0012 USEPA NRWC HH Water + Org**
85-01-8	Phenanthrene	NA	0.03 (J)	0.3	µg/L	SW-0017	8 / 27	0.03 - 0.08	0.3	No Screening Level
129-00-0	Pyrene	NA	0.01 (J)	0.08	µg/L	SW-0035	12 / 27	0.01 - 0.05	0.08	20 USEPA NRWC HH Water + Org

Notes:
CAS = chemical abstract service
HH Drinking Water = Human Health Protection Drinking Water Supply
HH Water + Org = Human Health for the Consumption of Water and Organisms
J = estimated concentration between reporting detection limit and detection limit
LDEQ = Louisiana Department of Environmental Quality
NA = not applicable
ND = not detected
NRWC = National Recommended Water Criteria
USEPA = US Environmental Protection Agency
µg/L = micrograms per liter

Bolded values indicated constituent maximum concentration exceeds screening level.
Refer to text for risk-based screening level references.

Table 4
Summary of Sediment Data (Fish Habitat)
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

CAS Number	Analyte Name	Minimum Detection	Maximum Detection	Units	Location of Maximum	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	BTV Concentration [1] (mg/kg)	Site Maximum > BTV?
7440-38-2	Arsenic	1.96 (J)	13.9 (J)	mg/kg	SD-0011	25 / 25	NA	13.9	13.9	NO
7440-43-9	Cadmium	0.169 (J)	1.05	mg/kg	SD-0008	8 / 25	0.757 - 2.39	1.05	1.82	NO
7439-97-6	Mercury	0.0989 (J)	2.03	mg/kg	SD-0013	13 / 25	0.234 - 0.523	2.03	0.32	YES
7782-49-2	Selenium	1.88 (J)	12.8 (J)	mg/kg	SD-0003	9 / 25	7.3 - 17.1	12.8	12.8	NO
83-32-9	Acenaphthene	0.002 (J)	2.37 (D)	mg/kg	SD-0023	20 / 31	0.005 - 0.51	2.37	0.007	YES
208-96-8	Acenaphthylene	0.01 (J)	7.85 (D)	mg/kg	SD-0009	31 / 31	NA	7.85	0.019	YES
120-12-7	Anthracene	0.013	14.8 (D)	mg/kg	SD-0009	31 / 31	NA	14.8	0.18	YES
56-55-3	Benzo[a]anthracene	0.015	7.86 (D)	mg/kg	SD-0023	31 / 31	NA	7.86	0.049	YES
50-32-8	Benzo[a]pyrene	0.021	11.6 (D)	mg/kg	SD-0009	31 / 31	NA	11.6	0.049	YES
205-99-2	Benzo[b]fluoranthene	0.029	12 (D)	mg/kg	SD-0009	31 / 31	NA	12	0.11	YES
191-24-2	Benzo[g,h,i]perylene	0.023	14 (D)	mg/kg	SD-0009	31 / 31	NA	14	0.018	YES
207-08-9	Benzo[k]fluoranthene	0.012	3.5	mg/kg	SD-0013	25 / 25	NA	3.5	0.033	YES
218-01-9	Chrysene	0.022	5.8	mg/kg	SD-0013	25 / 25	NA	5.8	0.1	YES
53-70-3	Dibenz(A,H)Anthracene	0.006 (J)	2.4 (D)	mg/kg	SD-0009	30 / 31	0.043 - 0.043	2.4	0.009	YES
206-44-0	Fluoranthene	0.025	19.2 (D)	mg/kg	SD-0023	31 / 31	NA	19.2	0.17	YES
86-73-7	Fluorene	0.003 (J)	4.89 (D)	mg/kg	SD-0023	26 / 31	0.043 - 0.26	4.89	0.082	YES
193-39-5	Indeno(1,2,3-C,D)Pyrene	0.023	14.2 (D)	mg/kg	SD-0009	31 / 31	NA	14.2	0.026	YES
85-01-8	Phenanthrene	0.013	20 (D)	mg/kg	SD-0023	31 / 31	NA	20	0.15	YES
129-00-0	Pyrene	0.027	16.6 (D)	mg/kg	SD-0023	31 / 31	NA	16.6	0.21	YES

Notes:
BTV = background threshold value
CAS = chemical abstract service
D = concentration from diluted aliquot
J = estimated concentration between reporting detection limit and detection limit
mg/kg = milligrams per kilogram
NA = not applicable
ND = not detected
1/ Refer to the Screening Level Ecological Risk Assessment for the SBA Shipyard Site, dated January 2021, regarding the derivation of BTVs.

Table 5
Summary of Sediment Data Screening (Crawfish Habitat)
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

CAS Number	Analyte Name	Minimum Detection	Maximum Detection	Units	Location of Maximum	Detection Frequency	Range of Detection Limits	Concentration Used for Screening	BTV Concentration [1] (mg/kg)	Site Maximum > BTV?
7440-38-2	Arsenic	1.96 (J)	13.9 (J)	mg/kg	SD-0011	38 / 40	14.4 - 38.5	13.9	13.9	NO
7440-43-9	Cadmium	0.169 (J)	1.05	mg/kg	SD-0008	16 / 40	0.5 - 3.85	1.05	1.82	NO
7439-97-6	Mercury	0.0593 (J)	2.03	mg/kg	SD-0013	17 / 40	0.205 - 0.992	2.03	0.32	YES
7782-49-2	Selenium	1.88 (J)	12.8 (J)	mg/kg	SD-0003	12 / 40	5 - 38.5	12.8	12.8	NO
83-32-9	Acenaphthene	0.002 (J)	46.4 (D)	mg/kg	SD-0062	36 / 54	0.004 - 0.51	46.4	0.007	YES
208-96-8	Acenaphthylene	0.009	28	mg/kg	SD-0040	54 / 54	NA	28	0.019	YES
120-12-7	Anthracene	0.013	914 (D)	mg/kg	SD-0033	54 / 54	NA	914	0.18	YES
56-55-3	Benzo[a]anthracene	0.009	92.2 (D)	mg/kg	SD-0062	54 / 54	NA	92.2	0.049	YES
50-32-8	Benzo[a]pyrene	0.01	96	mg/kg	SD-0040	54 / 54	NA	96	0.049	YES
205-99-2	Benzo[b]fluoranthene	0.029	140	mg/kg	SD-0040	54 / 54	NA	140	0.11	YES
191-24-2	Benzo[g,h,i]perylene	0.01	76	mg/kg	SD-0040	54 / 54	NA	76	0.018	YES
207-08-9	Benzo[k]fluoranthene	0.009	46	mg/kg	SD-0040	42 / 42	NA	46	0.033	YES
218-01-9	Chrysene	0.018	92	mg/kg	SD-0040	42 / 42	NA	92	0.1	YES
53-70-3	Dibenz(A,H)Anthracene	0.004 (J)	16	mg/kg	SD-0040	53 / 54	0.043 - 0.043	16	0.009	YES
206-44-0	Fluoranthene	0.021	371 (D)	mg/kg	SD-0062	54 / 54	NA	371	0.17	YES
86-73-7	Fluorene	0.003 (J)	75.6 (D)	mg/kg	SD-0062	47 / 54	0.043 - 0.26	75.6	0.082	YES
193-39-5	Indeno(1,2,3-C,D)Pyrene	0.012	72	mg/kg	SD-0040	54 / 54	NA	72	0.026	YES
85-01-8	Phenanthrene	0.007 (J)	357 (D)	mg/kg	SD-0062	54 / 54	NA	357	0.15	YES
129-00-0	Pyrene	0.018	291 (D)	mg/kg	SD-0062	54 / 54	NA	291	0.21	YES

Notes:
BTV = background threshold value
CAS = chemical abstract service
D = concentration from diluted aliquot
J = estimated concentration between reporting detection limit and detection limit
mg/kg = milligrams per kilogram
NA = not applicable
ND = not detected
1/ Refer to the Screening Level Ecological Risk Assessment for the SBA Shipyard Site, dated January 2021, regarding the derivation of BTVs.

Table 6
Summary of Tissue Screening Levels
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

		Toxicity Values							Calculated TSL[4] (mg/kg)		
CAS Number	Analyte Name	Cancer Slope Factor (mg/kg-day)$^{-1}$		Reference Dose (mg/kg-day)		Target Organ	Target Individual Chemical Risk[1]	Target Individual Hazard Quotient[2]	LDEQ TSL[3]	Carcinogenic TSL	Non-Carcinogenic TSL	Calculated TSL
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.3E+05	C	7.0E-10	I	Reproductive	NA	NA	NA	NA	NA	NA
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
3268-87-9	Octachlorodibenzo-p-dioxin	NA		NA		NA	NA	NA	NA	NA	NA	NA
39001-02-0	Octachlorodibenzofuran	NA		NA		NA	NA	NA	NA	NA	NA	NA
TEQWHO05-0.0	Toxic Equivalency Concentration (TEQ)	1.3E+05	C	7.0E-10	I	Reproductive	1.3E-05	1	1.6E-06	5.4E-07	1.6E-06	5.4E-07
7439-97-6	Mercury	NA		1.6E-04	C	Nervous system, kidney, development	NA	0.17	NA	NA	6.3E-02	6.3E-02
14488-53-0	Dibutyltin[5]	NA		3.0E-04	P	Immune	NA	0.33	NA	NA	2.3E-01	2.3E-01
78763-54-9	Monobutyltin[5]	NA		3.0E-04	P	Immune	NA	0.33	NA	NA	2.3E-01	2.3E-01
36643-28-4	Tributyltin[5]	NA		3.0E-04	P	Immune	NA	0.33	NA	NA	2.3E-01	2.3E-01
83-32-9	Acenaphthene	NA		6.0E-02	I	Liver	NA	0.5	NA	NA	7.0E+01	7.0E+01
208-96-8	Acenaphthylene[5]	NA		3.0E-02	I	Kidney	NA	0.17	NA	NA	1.2E+01	1.2E+01
120-12-7	Anthracene	NA		3.0E-01	I	No observed effect (NA)	NA	1	NA	NA	7.0E+02	7.0E+02
56-55-3	Benzo[a]anthracene	1.0E-01	E	NA		NA	1.3E-05	NA	NA	7.1E-01	NA	7.1E-01
50-32-8	Benzo[a]pyrene	1.0E+00	I	3.0E-04	I	Developmental	1.3E-05	0.5	NA	7.1E-02	3.5E-01	7.1E-02
205-99-2	Benzo[b]fluoranthene	1.0E-01	E	NA		NA	1.3E-05	NA	NA	7.1E-01	NA	7.1E-01
191-24-2	Benzo[g,h,i]perylene[5]	NA		3.0E-02	I	Kidney	NA	0.17	NA	NA	1.2E+01	1.2E+01
207-08-9	Benzo[k]fluoranthene	1.0E-02	E	NA		NA	1.3E-05	NA	NA	7.1E+00	NA	7.1E+00
218-01-9	Chrysene	1.0E-03	E	NA		NA	1.3E-05	NA	NA	7.1E+01	NA	7.1E+01
53-70-3	Dibenz(A,H)Anthracene	1.0E+00	E	NA		NA	1.3E-05	NA	NA	7.1E-02	NA	7.1E-02
206-44-0	Fluoranthene	NA		4.0E-02	I	Whole body (Kidney, Liver, Blood)	NA	0.17	NA	NA	1.6E+01	1.6E+01
86-73-7	Fluorene	NA		4.0E-02	I	Blood	NA	0.5	NA	NA	4.7E+01	4.7E+01
193-39-5	Indeno(1,2,3-C,D)Pyrene	1.0E-01	E	NA		NA	1.3E-05	NA	NA	7.1E-01	NA	7.1E-01
85-01-8	Phenanthrene[5]	NA		3.0E-02	I	Kidney	NA	0.17	NA	NA	1.2E+01	1.2E+01
129-00-0	Pyrene	NA		3.0E-02	I	Kidney	NA	0.17	NA	NA	1.2E+01	1.2E+01

Table 6
Summary of Tissue Screening Levels
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

Notes:
CAS = chemical abstract service
LDEQ = Louisiana Department of Environmental Quality
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram per day
NA = Not applicable
TSL = tissue screening level

Cancer Slope Factors:
C = California Environmental Protection Agency
E = indicates relative potency factor used to estimate toxicity value
I = Integrated Risk Information System

Reference Dose Factors:
C = California Environmental Protection Agency
I = Integrated Risk Information System
P = provisional peer-reviewed toxicity values

1/ Target Cumulative Risk (TCR) = 1 x 10^{-4}. Target Individual Chemical Risk (TICR) = TCR/Number of carcinogenic chemicals. TICR = 1 x 10^{-4} / 8 = 1.3 x 10^{-5}
2/ Target Cumulative Hazard Index (TCHI) = 1. Target Individual Hazard Quotient (TIHQ) = TCHI/(Number of non-carcinogenic chemicals). If there is more than one target organ for a chemical, the lowest associated TIHQ is used for the chemical.

Target Organ	Number of Chemicals	TIHQ
Reproductive	1	1
Blood	2	0.5
Liver	2	0.5
Kidney	6	0.17
Developmental	2	0.5
Body Weight	1	1
Immune	3	0.33
Nervous system	1	1
No observed effect (NA)	1	1

3/ LDEQ TSL from Tissue Screening Level Guidance (LDEQ et al., 2012).
4/ TSLs calculated used the following equations for carcinogenic and noncarcinogenic TSLs. Final calculated TSL is the minimum of the two toxicity-based TSLs.
LDEQ evaluates 2,3,7,8-Tetrachlorodibenzo-p-dioxin with Toxic Equivalency Concentration (TEQ). Per the LDEQ Tissue Screening Level Guidance (LDEQ et al., 2012), the World Health Organization 2006 TEFs were utilized in the TEQ calculation.

$$Carcinogenic\ TSL = \frac{TICR \times BW \times AT_c \times 365\ {}^{days}/_{year}}{EF \times ED \times CSF \times IRF}$$

$$Noncarcinogenic\ TSL = \frac{TIHQ \times BW \times AT_n \times 365\ {}^{days}/_{year}}{EF \times ED \times \left(\frac{1}{RfDo}\right) \times IRF}$$

Where:

Definition	(units)	Parameter	Input value
Tissue screening Level	(mg/kg)	TSL	Calculated
Target individual hazard quotient	unitless	TIHQ	Chemical-specific
Body Weight	(kg)	BW	70
Averaging time-noncancer	(years)	Atn	30
Exposure frequency	(days/year)	EF	365
Exposure duration	(years)	ED	30
Reference Dose	(mg/kg-day)	RfD	Chemical-specific
Fish ingestion rate	(g/day)	IRF	30
Target Individual Chemical Risk	unitless	TICR	Chemical-specific
Cancer Slope Factor	1/(mg/kg-day)	CSF	Chemical-specific
Averaging time-cancer	(years)	Atc	70

5/ Toxicological surrogates were used to develop TSLs due to lack of readily available toxicity values for this constituent of potential concern (COPC).
Tributyltin Compounds was used as a toxicological surrogate for dibutyltin ion and n-butyltin.
Tri-n-butyltin was used as a toxicological surrogate for tributyltin cation.
Pyrene was used as a toxicological surrogate for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.

LDEQ, LDHH, LDWF, and LDAF. 2012. Tissue Screening Level Guidelines for Issuance of Public Health Advisories for Selected Contaminants and Supporting Documentation. March.

Table 7
Summary of Sediment Data Screening (Fish)
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

					FISH					
CAS Number	Analyte Name	Site Maximum Concentration	Units	TEF	FISH BSAF	BSAF reference	Predicted Fish Concentration (mg/kg)	LDEQ TSL (mg/kg)	Calculated TSL (mg/kg)	Predicted Fish Concentration > TSL?
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	NA	NA	0.01	0.00193351	USACE, 2017	NA	NA	NA	NA
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA	NA	0.01	0.002730965	USACE, 2017	NA	NA	NA	NA
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA	NA	0.01	0.016445904	USACE, 2017	NA	NA	NA	NA
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.037788549	USACE, 2017	NA	NA	NA	NA
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.012451513	USACE, 2017	NA	NA	NA	NA
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.083840275	USACE, 2017	NA	NA	NA	NA
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.067839682	USACE, 2017	NA	NA	NA	NA
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.01471428	USACE, 2017	NA	NA	NA	NA
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	NA	NA	0.1	0.050993636	USACE, 2017	NA	NA	NA	NA
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	NA	NA	1	0.421798476	USACE, 2017	NA	NA	NA	NA
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	NA	NA	0.03	0.024949275	USACE, 2017	NA	NA	NA	NA
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.044042238	USACE, 2017	NA	NA	NA	NA
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	NA	NA	0.3	0.461667064	USACE, 2017	NA	NA	NA	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	NA	NA	1	0.486134236	USACE, 2017	NA	NA	NA	NA
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	NA	NA	0.1	0.389524428	USACE, 2017	NA	NA	NA	NA
3268-87-9	Octachlorodibenzo-p-dioxin	NA	NA	0.0003	0.000507764	USACE, 2017	NA	NA	NA	NA
39001-02-0	Octachlorodibenzofuran	NA	NA	0.0003	0.007999217	USACE, 2017	NA	NA	NA	NA
TEQWHO05-0.0	Toxic Equivalency (WHO 2005 - EDLx0.0)	NA	NA	NA	NA		NA	1.6E-06	5.4E-07	NA
7439-97-6	Mercury	2.03	mg/kg	NA	NA		NA	NA	6.3E-02	NA
14488-53-0	Dibutyltin	NA	NA	NA	7.452637321	RAIS 2021	NA	NA	2.3E-01	NA
78763-54-9	Monobutyltin	NA	NA	NA	5.988598359	RAIS 2021	NA	NA	2.3E-01	NA
36643-28-4	Tributyltin	NA	NA	NA	5.588432208	RAIS 2021	NA	NA	2.3E-01	NA
83-32-9	Acenaphthene	2.37	mg/kg	NA	5.632613957	DiToro and McGrath (2000)	1.33E+01	NA	7.0E+01	NO
208-96-8	**Acenaphthylene**	**7.85**	**mg/kg**	**NA**	**6.035732543**	**DiToro and McGrath (2000)**	**4.74E+01**	**NA**	**1.2E+01**	**YES**
120-12-7	Anthracene	14.8	mg/kg	NA	5.382077994	DiToro and McGrath (2000)	7.97E+01	NA	7.0E+02	NO
56-55-3	**Benzo[a]anthracene**	**7.86**	**mg/kg**	**NA**	**4.447438866**	**DiToro and McGrath (2000)**	**3.50E+01**	**NA**	**7.1E-01**	**YES**
50-32-8	**Benzo[a]pyrene**	**11.6**	**mg/kg**	**NA**	**4.687162247**	**DiToro and McGrath (2000)**	**5.44E+01**	**NA**	**7.1E-02**	**YES**
205-99-2	**Benzo[b]fluoranthene**	**12**	**mg/kg**	**NA**	**4.622000488**	**DiToro and McGrath (2000)**	**5.55E+01**	**NA**	**7.1E-01**	**YES**
191-24-2	**Benzo[g,h,i]perylene**	**14**	**mg/kg**	**NA**	**4.525952451**	**DiToro and McGrath (2000)**	**6.34E+01**	**NA**	**1.2E+01**	**YES**
207-08-9	**Benzo[k]fluoranthene**	**3.5**	**mg/kg**	**NA**	**4.613919223**	**DiToro and McGrath (2000)**	**1.61E+01**	**NA**	**7.1E+00**	**YES**
218-01-9	Chrysene	5.8	mg/kg	NA	4.854114172	DiToro and McGrath (2000)	2.82E+01	NA	7.1E+01	NO
53-70-3	**Dibenz(A,H)Anthracene**	**2.4**	**mg/kg**	**NA**	**4.447438866**	**DiToro and McGrath (2000)**	**1.07E+01**	**NA**	**7.1E-02**	**YES**
206-44-0	**Fluoranthene**	**19.2**	**mg/kg**	**NA**	**5.129204174**	**DiToro and McGrath (2000)**	**9.85E+01**	**NA**	**1.6E+01**	**YES**
86-73-7	Fluorene	4.89	mg/kg	NA	5.534902653	DiToro and McGrath (2000)	2.71E+01	NA	4.7E+01	NO
193-39-5	**Indeno(1,2,3-C,D)Pyrene**	**14.2**	**mg/kg**	**NA**	**4.443549137**	**DiToro and McGrath (2000)**	**6.31E+01**	**NA**	**7.1E-01**	**YES**
85-01-8	**Phenanthrene**	**20**	**mg/kg**	**NA**	**5.363274026**	**DiToro and McGrath (2000)**	**1.07E+02**	**NA**	**1.2E+01**	**YES**
129-00-0	**Pyrene**	**16.6**	**mg/kg**	**NA**	**5.201516578**	**DiToro and McGrath (2000)**	**8.63E+01**	**NA**	**1.2E+01**	**YES**

Notes:
BSAF = biota-sediment accumulation factor
CAS = Chemical Abstracts Service
LDEQ = Louisiana Department of Environmental Quality
mg/kg = milligrams per kilogram
NA = not applicable or not available
TEF = toxic equivalence factor
TSL = tissue screening level

Refer to text for BSAF references and discussion on TSL calculation.
Bolded values indicated constituent maximum concentration exceeds screening level.

DiToro, D. and J. McGrath. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. II. Mixtures and Sediments. Environmental Toxicology and Chemistry. 19: 1971-1982.
The Risk Assessment Information System (RAIS). https://rais.ornl.gov/. Accessed March 2021.
United States Army Corps of Engineers (USACE). 2017. Biota-Sediment Accumulation Factor (BSAF) Database. Online. Published July 8, 2016. U.S. Army Engineer Research and Development Center. Available online at: http://el.erdc.usace.army.mil/bsaf/ . Updated August 2017.

Table 8
Summary of Sediment Data Screening (Crawfish)
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

					BENTHIC INVERTEBRATES					
CAS Number	Analyte Name	Maximum Concentration	Units	TEF	Benthic BSAF	BSAF reference	Predicted Benthic Invertebrate Concentration (mg/kg)	LDEQ TSL (mg/kg)	Calculated TSL (mg/kg)	Predicted Benthic Invertebrate Concentration > TSL?
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	NA	NA	0.01	0.123014077	USACE, 2017	NA	NA	NA	NA
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	NA	NA	0.01	0.054803769	USACE, 2017	NA	NA	NA	NA
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	NA	NA	0.01	0.745537657	USACE, 2017	NA	NA	NA	NA
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.13643145	USACE, 2017	NA	NA	NA	NA
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.51053072	USACE, 2017	NA	NA	NA	NA
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.4724184	USACE, 2017	NA	NA	NA	NA
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.294309781	USACE, 2017	NA	NA	NA	NA
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	NA	NA	0.1	0.811729515	USACE, 2017	NA	NA	NA	NA
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	NA	NA	0.1	0.148204607	USACE, 2017	NA	NA	NA	NA
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	NA	NA	0.03	0.552410549	USACE, 2017	NA	NA	NA	NA
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	NA	NA	1	0.45197067	USACE, 2017	NA	NA	NA	NA
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	NA	NA	0.1	0.349775265	USACE, 2017	NA	NA	NA	NA
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	NA	NA	0.3	0.547609697	USACE, 2017	NA	NA	NA	NA
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	NA	NA	0.1	0.407166997	USACE, 2017	NA	NA	NA	NA
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	NA	NA	1	0.419184462	USACE, 2017	NA	NA	NA	NA
39001-02-0	Octachlorodibenzofuran	NA	NA	0.0003	0.080026417	USACE, 2017	NA	NA	NA	NA
3268-87-9	Octachlorodibenzo-p-dioxin	NA	NA	0.0003	0.063737007	USACE, 2017	NA	NA	NA	NA
TEQWHO05-0.0	Toxic Equivalency (WHO 2005 - EDLx0.0)	NA	NA	NA	NA		NA	1.6E-06	5.4E-07	NA
7439-97-6	**Mercury**	**2.03**	**mg/kg**	**NA**	**2.837**	**Bechtel-Jacobs (1998c)c**	**5.76E+00**	**NA**	**6.3E-02**	**YES**
14488-53-0	Dibutyltin	NA	NA	NA	6.06	RAIS 2021	NA	NA	2.3E-01	NA
78763-54-9	Monobutyltin	NA	NA	NA	4.87	RAIS 2021	NA	NA	2.3E-01	NA
36643-28-4	Tributyltin	NA	NA	NA	4.54	RAIS 2021	NA	NA	2.3E-01	NA
83-32-9	**Acenaphthene**	**46.4**	**mg/kg**	**NA**	**4.57649884**	**DiToro and McGrath (2000)**	**2.12E+02**	**NA**	**7.0E+01**	**YES**
208-96-8	**Acenaphthylene**	**28**	**mg/kg**	**NA**	**4.904032692**	**DiToro and McGrath (2000)**	**1.37E+02**	**NA**	**1.2E+01**	**YES**
120-12-7	**Anthracene**	**914**	**mg/kg**	**NA**	**4.37293837**	**DiToro and McGrath (2000)**	**4.00E+03**	**NA**	**7.0E+02**	**YES**
56-55-3	**Benzo[a]anthracene**	**92.2**	**mg/kg**	**NA**	**3.613544078**	**DiToro and McGrath (2000)**	**3.33E+02**	**NA**	**7.1E-01**	**YES**
50-32-8	**Benzo[a]pyrene**	**96**	**mg/kg**	**NA**	**3.808319326**	**DiToro and McGrath (2000)**	**3.66E+02**	**NA**	**7.1E-02**	**YES**
205-99-2	**Benzo[b]fluoranthene**	**140**	**mg/kg**	**NA**	**3.755375396**	**DiToro and McGrath (2000)**	**5.26E+02**	**NA**	**7.1E-01**	**YES**
191-24-2	**Benzo[g,h,i]perylene**	**76**	**mg/kg**	**NA**	**3.677336366**	**DiToro and McGrath (2000)**	**2.79E+02**	**NA**	**1.2E+01**	**YES**
207-08-9	**Benzo[k]fluoranthene**	**46**	**mg/kg**	**NA**	**3.748809369**	**DiToro and McGrath (2000)**	**1.72E+02**	**NA**	**7.1E+00**	**YES**
218-01-9	**Chrysene**	**92**	**mg/kg**	**NA**	**3.943967765**	**DiToro and McGrath (2000)**	**3.63E+02**	**NA**	**7.1E+01**	**YES**
53-70-3	**Dibenz(A,H)Anthracene**	**16**	**mg/kg**	**NA**	**3.613544078**	**DiToro and McGrath (2000)**	**5.78E+01**	**NA**	**7.1E-02**	**YES**
206-44-0	**Fluoranthene**	**371**	**mg/kg**	**NA**	**4.167478391**	**DiToro and McGrath (2000)**	**1.55E+03**	**NA**	**1.6E+01**	**YES**
86-73-7	**Fluorene**	**75.6**	**mg/kg**	**NA**	**4.497108406**	**DiToro and McGrath (2000)**	**3.40E+02**	**NA**	**4.7E+01**	**YES**
193-39-5	**Indeno(1,2,3-C,D)Pyrene**	**72**	**mg/kg**	**NA**	**3.610383674**	**DiToro and McGrath (2000)**	**2.60E+02**	**NA**	**7.1E-01**	**YES**
85-01-8	**Phenanthrene**	**357**	**mg/kg**	**NA**	**4.357660146**	**DiToro and McGrath (2000)**	**1.56E+03**	**NA**	**1.2E+01**	**YES**
129-00-0	**Pyrene**	**291**	**mg/kg**	**NA**	**4.22623222**	**DiToro and McGrath (2000)**	**1.23E+03**	**NA**	**1.2E+01**	**YES**

Notes:
BSAF = biota-sediment accumulation factor
CAS = Chemical Abstracts Service
LDEQ = Louisiana Department of Environmental Quality
mg/kg = milligrams per kilogram
Bolded values indicated constituent maximum concentration exceeds screening level.
NA = not applicable or not available
TEF = toxic equivalence factor
TSL = tissue screening level

Bechtel-Jacobs. 1998. Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-112. August 1998.
DiToro, D. and J. McGrath. 2000. Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. II. Mixtures and Sediments. Environmental Toxicology and Chemistry. 19: 1971-1982.
The Risk Assessment Information System (RAIS). https://rais.ornl.gov/. Accessed March 2021.
United States Army Corps of Engineers (USACE). 2017. Biota-Sediment Accumulation Factor (BSAF) Database. Online. Published July 8, 2016. U.S. Army Engineer Research and Development Center. Available online at: http://el.erdc.usace.army.mil/bsaf/ . Updated August 2017.

Table 9
Target Site-Related Analytes
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

Target Analyte Class	Individual Target Analytes
Metals	Total Mercury
	Methylmercury
PAHs	Acenaphthene
	Acenaphthylene
	Anthracene
	Benzo(a)anthracene
	Benzo(a)pyrene
	Benzo(b)fluoranthene
	Benzo(g,h,i)perylene
	Benzo(k)fluoranthene
	Chrysene
	Dibenzo(a,h)anthracene
	Fluoranthene
	Fluorene
	Indeno(1,2,3-c,d)pyrene
	Phenanthrene
	Pyrene
Other Potential Target Analytes (Pending Review of 2021 Sediment Analytical Results)	
Organotins	Tributyltyin[1]
Polychlorinated dibenzodioxins and dibenzofurans[1]	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin
	1,2,3,4,6,7,8-Heptachlorodibenzofuran
	1,2,3,4,7,8,9-Heptachlorodibenzofuran
	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin
	1,2,3,4,7,8-Hexachlorodibenzofuran
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin
	1,2,3,6,7,8-Hexachlorodibenzofuran
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin
	1,2,3,7,8,9-Hexachlorodibenzofuran
	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
	1,2,3,7,8-Pentachlorodibenzofuran
	2,3,4,6,7,8-Hexachlorodibenzofuran
	2,3,4,7,8-Pentachlorodibenzofuran
	2,3,7,8-Tetrachlorodibenzo-p-dioxin
	2,3,7,8-Tetrachlorodibenzofuran
	Octachlorodibenzo-p-dioxin
	Octachlorodibenzofuran

Notes:
1/ The inclusion of tributyltins and polychlorinated dibenzodioxins and dibenzofurans will be contingent upon the review of 2021 sediment analytical results consistent with the Fish Tissue Sampling Work Plan.
PAH = polycyclic aromatic hydrocarbons

Table 10
Fish and Crawfish Sample Summary
Fish Tissue Sampling Work Plan
SBA Shipyard - Jennings, LA

Site Feature	Target Species (number of samples)		
	Bass	Catfish	Crawfish
IAC-6 – Barge Slip	1	1	1
IAC-7 – Dry Dock	1	1	1
IAI-6 – Vessel Slip 1 on Northern Property	1	1	1
IAI-7 – Vessel Slip 2 on Northern Property	1	1	1
IAI-1 – Southern Wetland Area	--	--	1
IAI-8 – Off-Site Wetland Area	--	--	1
IAC-5 – Barge Cleaning Area Drainage Ditch	--	--	1
Background (Mermentau River - Upstream)	1	1	1
Background (Mermentau River - Downstream)	1	1	1
Total number of field samples		21	
Total number of quality control (QC) samples		6	
Total number of field and QC samples		27	

Notes:
Crawfish sampling has been added to IAC-6, IAC-7, IAI-6, and IAI-7 based on comments received from LDEQ during the February 24, 2021 teleconference.

The small size (e.g., IAI-6 and IAI-7) and physically degraded habitats of the heavily modified, man-made Site features (e.g., IAC-7) may not support large populations of fish or crayfish. Therefore, other surrogate fish species may need to be considered for tissue analysis depending on the abundance and catch rates of the target species. If suitable numbers and sizes of appropriate surrogate species are not captured, the number of proposed tissue samples may be reduced accordingly.

IAC = Investigation Area of Concern
IAI = Investigation Area of Interest

Figures

Legend

Property Line

Northern Property

Southern Property

RIVER

MERMENTAU

ABANDONED

JEFFERSON DAVIS PARISH

ACADIA PARISH

1,600 800 0 1,600

Scale In Feet

SBA Shipyard
Site Location Map

EHS Support

FIGURE 1

Reviewed By: SLindenmuth

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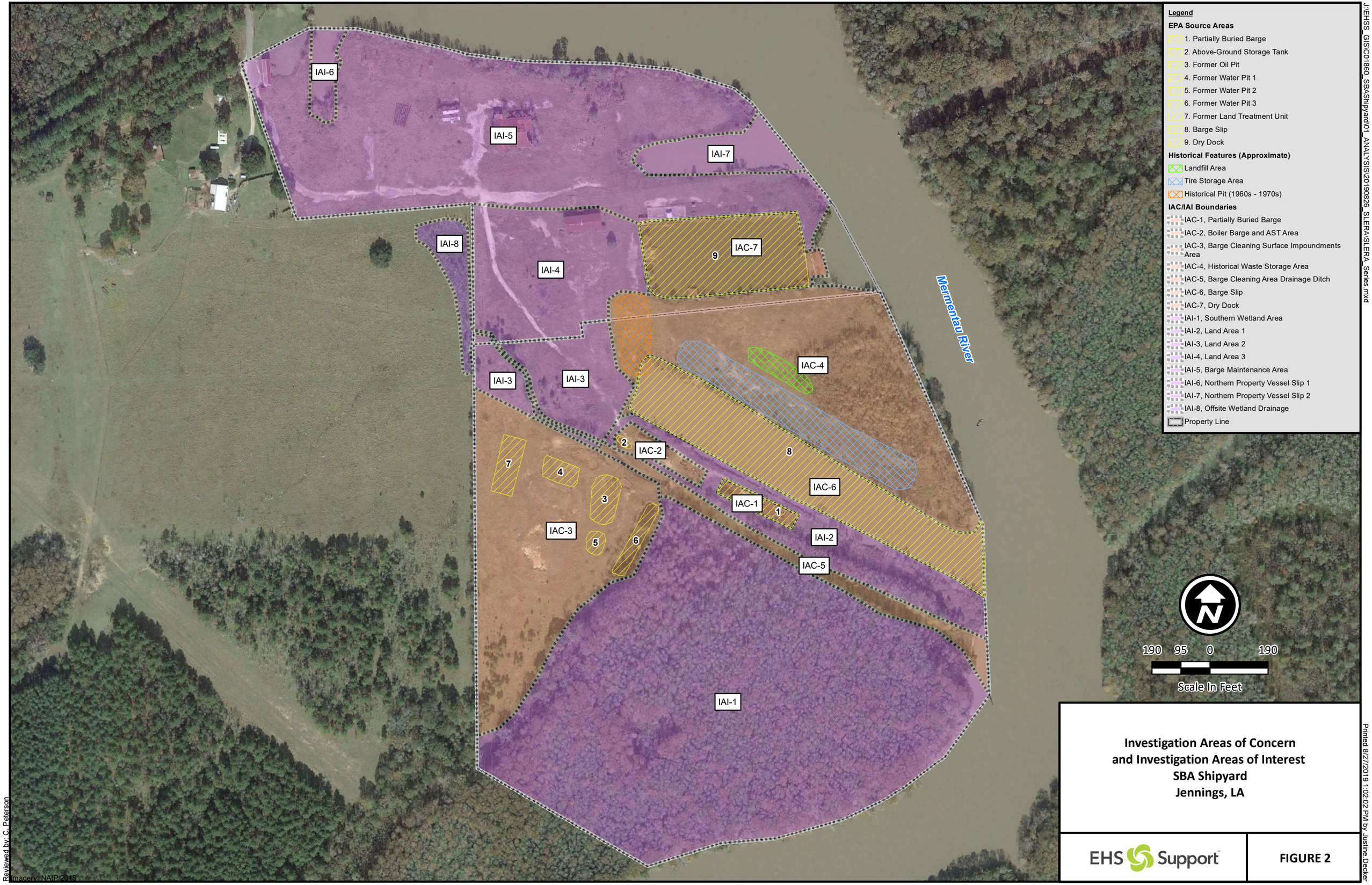
J:\EHS_GIS\C01860_SBAShipyard\01_ANALYSIS\20180508_RIWorkPlan\RI Report Figure 1 - Site Location Map.mxd



Legend

EPA Source Areas

- 1. Partially Buried Barge
- 2. Above-Ground Storage Tank
- 3. Former Oil Pit
- 4. Former Water Pit 1
- 5. Former Water Pit 2
- 6. Former Water Pit 3
- 7. Former Land Treatment Unit
- 8. Barge Slip
- 9. Dry Dock

Historical Features (Approximate)

- Landfill Area
- Tire Storage Area
- Historical Pit (1960s - 1970s)

IAC/IAI Boundaries

- IAC-1, Partially Buried Barge
- IAC-2, Boiler Barge and AST Area
- IAC-3, Barge Cleaning Surface Impoundments Area
- IAC-4, Historical Waste Storage Area
- IAC-5, Barge Cleaning Area Drainage Ditch
- IAC-6, Barge Slip
- IAC-7, Dry Dock
- IAI-1, Southern Wetland Area
- IAI-2, Land Area 1
- IAI-3, Land Area 2
- IAI-4, Land Area 3
- IAI-5, Barge Maintenance Area
- IAI-6, Northern Property Vessel Slip 1
- IAI-7, Northern Property Vessel Slip 2
- IAI-8, Offsite Wetland Drainage
- Property Line

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Reviewed by: C. Peterson

Imagery: NAIP 2015

Investigation Areas of Concern and Investigation Areas of Interest SBA Shipyard Jennings, LA

EHS Support

FIGURE 2

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ATTACHMENT A STANDARD OPERATING PROCEDURES

SOP-67 Fish Tissue Sampling

Purpose

The purpose of this Standard Operating Procedure (SOP) is to describe fish tissue sampling procedures for laboratory analytical analyses. Fish tissue sampling enables characterization of constituents of potential concern (COPCs) for assessment of potential bioaccumulation exposure pathways to fish and ingestion exposure pathways to piscivorous wildlife and human receptors. The procedures described herein are generalized and may be modified to meet the constraints presented by project objectives, site conditions, and equipment limitations. It is beyond the scope of this SOP to describe procedures for all equipment types and project objectives.

Safety Precaution: When working near or over water, additional safety precautions must be taken to ensure the safety of sampling personnel. When conducting sampling from a boat, appropriate boating safety procedures will be followed. Factors, such as safe access and handling, and adverse weather conditions will influence sample collection.

Relevant EHS Support SOPs

- SOP-04 Field Documentation
- SOP-05 Sample Management and Shipping
- SOP-06 Pre-Field Mobilization Procedures
- SOP-07 Investigative Derived Waste Management
- SOP-08 Field Equipment Operation and Calibration
- SOP-09 Field Equipment Decontamination
- SOP-12 Quality Assurance/Quality Control Samples

Attachments

- Attachment A General Fish Collection Procedures by Gear Type

Required Materials

- Field logbook and field documentation
- Site maps, site layouts, and site plans
- Health and Safety Plan (HASP)
- Appropriate personal protective equipment (PPE)
- Black waterproof and/or indelible ink pens
- Safety equipment (including personal floatation device [PFD], lifeline, waders, as applicable)
- Scientific collection permit, as applicable
- Fish collection gear (nets, traps, etc.)
- Processing equipment (buckets, utensils, measuring board, scale)
- Appropriate sample containers, sampling kits, labels, coolers, ice, dry ice (transport), Chain-of-Custody (COC) forms, tape, and plastic bags

- Global Positioning System (GPS)
- Camera
- Decontamination supplies

1 General Fish Tissue Sampling Procedures

The following sections describe the general procedures for the sampling of fish tissue for laboratory analytical analyses.

1.1 Sampling Methodology

Fish will be collected by trained personnel and approved sampling techniques in accordance with the conditions stated in the scientific collection permit, sampling procedures described herein, and other applicable guidance. A scientific collection permit will be obtained from the appropriate fish and wildlife agency prior to the commencement of sampling, as applicable. Fish may be collected using a combination of passive and/or active gear types based on project objectives and field/habitat conditions. Gear types may include seine, minnow trap, cast net, hoop net, gill net, trawl, hook and line, electrofishing, and/or other common fisheries gear types. Collection procedures using common gear types are summarized in **Attachment A**. All non-target fish species captured will be released as quickly as practicable to minimize handling stress.

Fish samples designated for COPC analysis will be processed as follows:

- Identify fish to species.
- Inspect and note any gross physical anomalies.
- Measure total length to nearest millimeter (mm) and weight to nearest gram (g) for each fish.
- Assign fish to composites of similarly sized individuals (smallest fish within 75 percent of length of largest fish), as appropriate. Alternately, fish may be analyzed individually. The use of composite samples versus individual samples will depend on project objectives and tissue mass requirements for laboratory analytical analyses.
- Rinse fish with deionized water to remove any sediment, vegetation, and debris, and blot dry with lint free paper towels (e.g., Kimwipe).
- Place fish into laboratory-supplied sample container, store in cooler on wet ice while sampling, and freeze as soon as logistically practical upon return from the field.

A trained scientist will make observations regarding habitat type, tidal stage (where applicable), water depth, and any other pertinent information including collection method, time of gear deployment and retrieval, and GPS coordinates. The field team manager will confirm that pertinent information is being accurately recorded in the field notebook and/or on field data sheets.

In addition to field samples, quality assurance/quality control (QA/QC) samples will be analyzed at the laboratory. QA/QC samples will include duplicate analyses of submitted sample volumes and matrix spike/matrix spike duplicate (MS/MSD) analyses. Duplicate samples and MS/MSD samples will be analyzed at a rate of five percent of the total samples collected for the investigation.

Samples will be clearly labeled and handled according to COC procedures. Samples will be labeled with the sample number, date and time of collection, initials of sampling personnel, requested analyses, and method of preservation using indelible ink. A COC form will be prepared to document the possession of

the samples from collection through shipping, storage, and analysis to data reporting and disposal. The times of sample collections and relevant observations will be recorded in the field log.

1.2 Sample Transport and Analysis

Fish tissue samples will be submitted under proper COC to a certified analytical laboratory, frozen, and packed on dry ice. Tissue samples will be prepared and analyzed for COPECs in accordance with applicable United States Environmental Protection Agency (USEPA) and/or ASTM analytical methods. When shipping to the laboratory, coolers should not weigh more than 50 pounds.

1.3 Records

Field notes will be kept in a bound field logbook or approved field documentation following the format specified in SOP-04 Field Documentation. Specific documentation may include health and safety documentation, precipitation data, and photographs. Detailed records will be maintained during investigation activities, particularly with respect to location, depth, color, odor, conditions, and water measurements from field monitoring equipment. Required records include:

- Required site maps and HASP forms
- Instrument calibration
- Fish tissue sampling data
  - Description of location and photographs
  - Distance of sample location from right or left edge of water or embankment
  - GPS coordinates
  - Approximate water depth
  - Date started/ended at location
  - Station conditions (e.g., floating oil or debris, gassing, direction of flow)
  - Description of sampler and equipment
  - Contractor name and equipment used, if applicable
  - Water quality parameter measurements.
- Weather observations (e.g., air temperature, wind speed, cloud coverage, approximate wave height)
- Any problems encountered or deviations from this SOP
- Summary of daily activities and personnel on-site

Attachment A General Fish Collection Procedures by Gear Type

Fish Collection by Fish Traps

The following procedures will be used to collect fish using traps, such as minnow traps or eel pots, collectively referred to as fish traps:

- Select the area to be sampled based on habitat conditions, water depth, and applicable regulations. Avoid areas with heavy boat/vessel traffic.
- Use buoys to visibly mark locations of fish traps. The buoy will have a permanent identification tag bearing the license/collection permit number or equivalent. Mark buoy with fluorescent/reflective paint or tape.
- Upon arrival at sample locations, check fish traps to confirm they are working properly and, if necessary, attach weights prior to baiting.
- Bait the traps and lower them over the side of the boat.
- Confirm the trap is resting on the bottom and that the buoy is clearly visible on the water surface with enough slack to account for tide so that the trap can be easily retrieved. Use a GPS unit to take coordinates of the trap locations and record any pertinent sampling location and condition descriptions in the field notebook.
- Check fish traps at least once per day (i.e., every 24 hours).
- To check the trap, pick up the buoy and pull up the line and trap to check for catch. If target species have been collected, remove them from the trap. For non-target species, count and release these individuals as quickly as possible to minimize handling stress.
- Process target species as described in **Section 1.1**.

Fish Collection by Hoop Net

The following procedures will be used to collect fish using a hoop net:

- Select the area to be sampled based on habitat conditions and water depth. Do not set hoop nets in or close to navigation channels, marinas, or other areas of heavy boat/vessel traffic.
- Record coordinates using a GPS unit.
- Bait the inside of the last compartment of the hoop net (cod end) if catfish or other bottom-feeders are desired.
- Set the upstream end of the hoop net by attaching the leader line to an anchor or pole and extending the line out into the water until it is taut.
- Extend the hoops of the trap in line with the leader line and pull on the end of the net until all of the hoops are upright, while lowering into water.
- Set the downstream end of the hoop net (opening) by extending the leader line out into the water until it is taut and attaching the leader line to an anchor or pole.
- Mark hoop net with a flagged buoy at each anchored end of the net. Buoys will have a permanent identification tag bearing the license/collection permit number or equivalent. Buoys will be marked with fluorescent/reflective paint or tape.
- Allow the net to soak for the prescribed sampling period (e.g., 24–48 hours).
- To retrieve, arrive at the buoy at the downstream end of the hoop net (opening), snag the buoy line with a boat hook, and pull the buoy and its anchor into the boat.
- Retrieve the hoops in sequence while moving upstream.
- Starting at the mouth of the net, shake the captured fish into the closed cod end of the net.
- Once all captured fish are in the cod end of the net, empty them into the collection containers.

- Process target species as described in **Section 1.1**.

Fish Collection by Gill Net

The following procedures will be used to collect fish using a gill net:

- Select the area to be sampled based on habitat conditions and water depth. Do not set gill nets in or close to navigation channels, marinas, or other areas of heavy boat/vessel traffic.
- Record coordinates using a GPS unit.
- Mark gill nets with a flagged buoy at each end of the net. The buoys will have a permanent identification tag bearing the license/collection permit number or equivalent. Buoys will be marked with fluorescent/reflective paint or tape.
- Remove any obstructions from the deck of the boat so as to not entangle the net. Prior to paying out the net, remove or secure buttons, straps/buckles, and other loose articles of clothing that may catch in the net so these items do not become entangled.
- Use net with appropriately sized mesh and appropriate depth for the target species. Attach the end of the gill net to a buoy, anchor it, and deploy it overboard. Back the boat in reverse while allowing the net to pay out. Set the net perpendicular to the likely direction of fish movement and once it is stretched taught, anchor the other end and attach a buoy.
- Observe the net to make sure it is holding and that the buoys are visible prior to departing. After the prescribed set time (nets will be checked at least once every 24 hours), return to the net and check for fish. Clear the boat deck of obstructions and secure any loose or entangling articles of clothing. Upon arrival at the net, approach the net from the downwind or down current side, pick up the buoy from one end, and walk the boat along the net, lifting it up to check for fish.
- Remove any captured fish from the net and place them in a clean holding container (e.g., cooler, buckets, plastic tote) with site water. For non-target species, count and release these individuals as quickly as possible to minimize handling stress.
- After the entire net has been checked for fish, remove the captured fish from the holding container. Retain any target species that meet the minimum target size.
- Pull the net into the boat and coil it carefully in a plastic tub or container so that it can easily be re-set.
- Process target species as described in **Section 1.1**.

Fish Collection by Trawl

The following procedures will be used to collect fish using a trawl:

- Select area to be sampled based on habitat conditions and consulting navigation charts for the presence of potential obstructions. Areas with potential underwater obstructions should be avoided.
- Record the start and stop points of each trawl line using a GPS unit.
- Upon arrival at target sampling locations, set up the trawl net with appropriately sized mesh for the target species.
- Attach the trawl net to the rope or cables, deploy the net from the back of the boat.
- Motor the boat forward at an appropriate speed to keep the net at the target position within the water column.

- While the boat is in motion, do not stand between the trawl, ropes, or winches or within the swing radius of the winch arm in case there is a snag.
- After the prescribed trawl time, winch or pull the net into the boat, and release the cod end to empty the catch onboard.
- Remove fish from the net and place them in a clean holding container with site water. Retain target species that meet the minimum target size. For non-target species, count and release these individuals as quickly as possible to minimize handling stress.
- Pull the net into the boat and store it securely.
- Process target species as described in **Section 1.1**.

Fish Collection by Seine

The following procedures will be used to collect fish using a seine:

- Select the area to be sampled based on habitat conditions and water depth. Seine nets will not be deployed in areas with underwater obstructions or other hazards.
- Record the coordinates using a GPS unit.
- Select a seine net with appropriate length, depth, and mesh size for the target species and habitat at the sample location.
- One person (or boat) will take an end of the net attached to a brail and wade (or motor) out from shore and will then return to shore, forming a semi-circle.
- Crew members at both ends of the net will then pull the net to shore, keeping the lead line in front of the float line while shaking back any fish towards the middle of the net.
- When there is only a small section of the net remaining in the water, lift the lead lines and float lines simultaneously from both directions to entrap any fish in the net. The net may then be moved to shore or a boat to sort the catch.
- Remove fish from the net and store them in clean holding containers with site water. Retain target species that meet the minimum target size. For non-target species, count and release these individuals a quickly as possible to minimize handling stress.
- Pull the net into the boat and store it securely.
- Process target species as described in **Section 1.1**.

Fish Collection by Electrofishing

Electrofishing is the collection of fishes that are momentarily stunned by introduction of an electric current into the water. A typical electrofishing unit consists of a generator that produces an electric current, a power control device that allows modification of the electric current to maximize efficiency and reduce potential injuries to the fish, and one or more electrodes that are submerged beneath the water surface.

Electrofishing can be conducted using direct current (DC), pulsed DC, and alternating current (AC). Research has shown that the greatest risk of injury to fish occurs with use of AC. The lowest incidence of injury and death is associated with use of DC; however, maintaining a constant DC field requires a larger power source than is commonly available. There is little overall difference between DC and pulsed DC in the rates of injury and death to fishes; therefore, pulsed DC is the most commonly used and recommended waveform.

Fishes responses to DC and pulsed DC fields are fairly predictable. If the field is detected from a distance, fish will evade (flee from) the field. Within the field, fish often face and then approach the anode (positively charged electrode). There is a progressive inhibition of swimming as the fish nears the anode, which includes taxis (induced movement toward the anode), narcosis (a state of electrically induce immobility in which the muscles are relaxed), and loss of equilibrium.

The following procedures will be used to collect fish using electrofishing:

- Select area to be sampled based on habitat conditions and by consulting navigation charts, where available.
- Record the electrofishing run start and stop locations using a GPS unit and time of each electrofishing run (either total time or time of electric current output).
- Collect fish using either a boat-mounted, barge-mounted, or backpack electrofishing unit or some combination of units depending on the size of waterbody being sampled.
- Electrofishing unit waveform and amperage should be determined based on properties (conductivity and temperature) of the water being sampled and species being targeted.
- Use the minimum current necessary to induce taxis and narcosis in fishes. Use of low- to mid-range currents of pulsed DC is intended to minimize the potential for injury of fishes collected by electrofishing. Pulse rate and duration are set to minimum effective values, determined through experience, to minimize the length of time fish are subject to current, further reducing the potential for injury. Use of the minimum necessary current should also minimize any stress experienced by fishes collected by electrofishing.
- Once stunned, fishes are immobilized briefly (5-10 seconds) before they recover and swim off. Stunned fishes are captured by use of a dip net, placed in a live-well, and are then handled as described in appropriate study protocols.
- Process target species as described in **Section 1.1**.

Fish Collection by Angling, Trotline, and Limb Line

Angling with hook and line can be an effective way to collect fish samples depending on the target species. Trotlines and limb lines are among the passive techniques that can be used as the primary method for capture or to supplement others, where permissible. Trotlines are typically a long line with a multiple baited hooks. The trotline is anchored at both ends and set in the water for a period of time. Limb lines are baited hooks that are attached to tree limbs or stakes on the shore. Both of these methods can be used in rivers, lakes, and reservoirs.

Process target species caught by angling as described in **Section 1.1**.

SOP-68 Crawfish Sampling

Purpose

The purpose of this standard operating procedure (SOP) is to describe the sampling of crawfish (or crayfish) for laboratory analytical analyses. The assessment of constituents of potential concern (COPCs) in crawfish is necessary for the evaluation of potential bioaccumulation exposure pathways to crawfish and ingestion exposure pathways to wildlife and human receptors. The procedures described herein are generalized and may be modified to meet the constraints presented by project objectives, site conditions, and equipment limitations. It is beyond the scope of this SOP to describe procedures for all equipment types and project objectives.

Safety Precaution: When working near or over water, additional safety precautions must be taken to ensure the safety of sampling personnel. When conducting sampling from a boat, appropriate boating safety procedures should be followed. Factors, such as safe access and handling, and adverse weather conditions will influence sample collection.

Relevant EHS Support SOPs

- SOP-04 Field Documentation
- SOP-05 Sample Management and Shipping
- SOP-06 Pre-Field Mobilization Procedures
- SOP-07 Investigative Derived Waste Management
- SOP-08 Field Equipment Operation and Calibration
- SOP-09 Field Equipment Decontamination
- SOP-12 Quality Assurance/Quality Control Samples

Required Materials

- Field logbook and field documentation
- Site maps, site layouts, and site plans
- Health and Safety Plan (HASP)
- Appropriate personal protective equipment (PPE)
- Black waterproof and/or indelible ink pens
- Safety equipment
- Scientific collection permit, as applicable
- Crawfish collection gear (traps, dip net, bait, etc.)
- Processing utensils
- Deionized water
- Appropriate sample containers, and sampling kits
- Labels, coolers, ice, dry ice (transport), Chain-of-Custody (COC) forms, tape, and plastic bags
- Global Positioning System (GPS)
- Camera

- Decontamination supplies
- Kimwipes

1 General Crawfish Sampling Procedures

The following sections describe the general procedures for the sampling of crawfish for laboratory analytical analyses.

1.1 Sampling Methodology

Crawfish will be collected by trained personnel through approved sampling techniques in accordance with the conditions stated in the scientific collection permit, sampling procedures described herein, and other applicable guidance. A scientific collection permit will be obtained from the appropriate fish and wildlife agency prior to the commencement of sampling, as applicable. Crawfish may be collected using a combination of techniques; however, trapping is typically the most effective and preferred method of collection.

The following procedures will be used to collect crawfish using traps:

- Select the area to be sampled based on habitat conditions.
- Upon arrival at sample locations, check crawfish traps to confirm that they are working properly and, if necessary, attach weights prior to baiting.
- Bait and set traps.
- Confirm the trap is resting on the bottom and that the buoy is clearly visible on the water surface with enough slack to account for tide (where applicable) so that the trap can be easily retrieved. Use a GPS unit to take coordinates of the trap locations and record any pertinent sampling location and condition descriptions in the field logbook.
- Use buoys to visibly mark locations of crawfish traps. Mark buoy with fluorescent/reflective paint/tape and permanent identification tag bearing the license/collection permit number or equivalent.
- Check crawfish traps at least once per day (i.e., every 24 hours).
- To check the trap, pick up the buoy and pull up the line and trap to check for catch. If target species have been collected, remove them from the trap. For non-target species, count and release these individuals as quickly as possible to minimize handling stress.
- Process target species as described below.

Captured crawfish will be identified to the lowest taxonomic level practical, typically genus or species. Crawfish captured for ecological assessment will be depurated for approximately 24 hours to eliminate potential contents within the digestive tract. Depuration will be conducted by holding crawfish in clean water filled depuration chambers. Following depuration, crawfish will be rinsed with deionized water and blotted dry with Kimwipes (or equivalent) to remove excess water. Crawfish collected for human health assessment will be rinsed with deionized water and either processed at the field site or by the selected analytical laboratory. Tissue analyses for human health assessment are typically conducted on abdominal muscle tissue, not whole body as typically done for ecological assessment. Voucher specimens may be retained for verification of field identification.

In addition to field samples, quality assurance/quality control (QA/QC) samples will be collected for analysis by the laboratory. QA/QC samples will include duplicate analyses of submitted sample volumes

and matrix spike/matrix spike duplicate (MS/MSD) analyses. Duplicate samples and MS/MSD samples will be analyzed at a rate of five percent of the total samples collected for the investigation.

Samples will be clearly labeled and handled according to COC procedures. Samples will be labeled with the sample number, date and time of collection, initials of sampling personnel, requested analyses, and method of preservation using indelible ink. A COC form should be prepared to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The times of sample collections and relevant observations should be recorded in the field log.

1.2 Sample Transport and Analysis

Crawfish samples will be submitted under proper COC to a certified analytical laboratory frozen and packed on dry ice. Samples will be prepared and analyzed in accordance with applicable United States Environmental Protection Agency (USEPA) and/or ASTM analytical methods. When shipping to the laboratory, coolers should not weigh more than 50 pounds.

1.3 Records

Field notes should be kept in a bound field logbook or approved field documentation following the format specified in SOP-04 Field Documentation. Specific documentation may include health and safety documentation, precipitation data, and photographs. Detailed records should be maintained during investigation activities, particularly with respect to location, depth, color, odor, conditions and data from field monitoring equipment. Required records include:

- Required site maps and HASP forms
- Crawfish sampling data
    - Description of location and photographs
    - GPS coordinates
    - Date collected at location
    - Description of method and equipment
    - Description of specimen
- Weather observations (e.g., air temperature, wind speed, cloud coverage)
- Any problems encountered or deviations from this SOP
- Summary of daily activities and personnel on-site